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RATIONALE DOCUMENT FOR THE DEVELOPMENT OF AN INTERIM ONTARIO DRINKING WATER OBJECTIVE FOR TRITIUM

DECEMBER 1994

Ontario

Ministry of
Environment
and Energy

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RATIONALE DOCUMENT

FOR THE DEVELOPMENT OF

AN INTERIM ONTARIO DRINKING WATER OBJECTIVE

FOR TRITIUM

DECEMBER 1994

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PREFACE

This document is divided into two parts. Part I contains the original rationale for establishing the interim Ontario drinking water objective for tritium. Part II describes the issues which were considered by the Minister in reaching a decision on the revised tritium objective.

Part I of the report was originally published and distributed in November 1993, as supporting documentation for public consultation on a revised drinking water objective for tritium. The report underwent a 90 day public review period conducted by the Minister's Advisory Committee on Environmental Standards (ACES). During the review period, ACES received 84 written responses and 11 deputation presentations.

In May 1994, ACES made its recommendations to the Minister in a report entitled " *A Standard For Tritium - A Recommendation to the Minister of Environment and Energy*".

On December 22 1994, the Minister announced the new interim Ontario Drinking Water Objective (ODWO) for tritium of 7000 Becquerels per litre (Bq/L). In making this decision, the Minister considered the issues raised by ACES, economic consequences, and other issues identified in focussed consultations with key stakeholders.

Ontario Hydro also made a corporate commitment to keep levels of tritium in drinking water, near their facilities, below an annual average of 100 Bq/L.

ACES has raised a number of concerns about the apparent inconsistencies in risk levels used in setting standards for radionuclides compared to risk levels used for chemical standards. The Minister determined that these issues required resolution at the national level due to the mandate of the federal government in the area of nuclear regulation and also because of the requisite technical expertise at Health Canada. As a result, the Minister has referred the ACES' recommendations to Health Canada and Natural Resources Canada for consideration and action.

The Ministry will be reviewing the interim ODWO for tritium when the federal agencies conclude their evaluations.

December 1994

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TABLE OF CONTENTS

		PAGE
	PREFACE	(i)
	ACKNOWLEDGEMENTS	(ii)
	TABLE OF CONTENTS	(iii)
	EXECUTIVE SUMMARY	(vii)
	PART I - RATIONALE FOR THE DEVELOPMENT OF AN INTERIM ONTARIO DRINKING WATER OBJECTIVE FOR TRITIUM	
1.0	BACKGROUND	1
2.0	INTRODUCTION	2
3.0	THE PROPERTIES OF TRITIUM	3
4.0	TRITIUM: SOURCES AND OCCURRENCE	4
5.0	EXPOSURE TO IONIZING RADIATION	4
	5.1 Natural Sources of Radiation	5
	5.2 Other Sources	5
6.0	HEALTH EFFECTS OF IONIZING RADIATION	6
	6.1 Assessing the Effective Dose of Radiation	7
	6.2 Estimation of the Risk Associated with Exposure to Ionizing Radiation	8
7.0	DRINKING WATER GUIDELINES FOR RADIONUCLIDES	9
	7.1 World Health Organization Guidelines	9
	7.2 Canadian Drinking Water Guidelines	10
	7.3 Ontario Drinking Water Guidelines	10
	7.4 United States Environmental Protection Agency Limits	11
	7.5 Calculation of an Interim Ontario Drinking Water Objective for Tritium	11

TABLE OF CONTENTS

		PAGE
8.0	THE NATURE AND APPLICATION OF DRINKING WATER GUIDELINES	12
	8.1 WHO Guidelines	12
	8.2 Canadian Drinking Water Guidelines	14
	8.3 Ontario Drinking Water Objectives	14
9.0	TRITIUM IN DRINKING WATER IN ONTARIO	15
10.0	SOCIO-ECONOMIC IMPACT OF REVISED DRINKING WATER OBJECTIVE FOR TRITIUM	15
11.0	PROPOSED INTERIM DRINKING WATER OBJECTIVE FOR TRITIUM	16

PART II - CONSIDERATION OF ISSUES AND THE ADVISORY COMMITTEE ON ENVIRONMENTAL STANDARDS' (ACES) RECOMMENDATIONS

12.0	STAKEHOLDER VIEWS ON THE ACES' RECOMMENDATIONS	17
13.0	CURRENT EXPOSURES TO TRITIUM AND OTHER RADIONUCLIDES IN DRINKING WATER	17
14.0	RADIONUCLIDE MAXIMUM ACCEPTABLE CONCENTRATION	19
15.0	ACES RECOMMENDATIONS REFERRED TO FEDERAL AGENCIES	19
16.0	DECISION ON ONTARIO'S NEW DRINKING WATER OBJECTIVE FOR TRITIUM	21

TABLE OF CONTENTS

		PAGE
17.0	RESPONSE TO OTHER ACES' RECOMMENDATIONS	21
17.1	Recommendation for a Multi-Media Approach	21
17.2	Recommendation for a MOEE Policy on Risk Estimation	21
17.3	Recommendation for Placement of Toxic, Persistent Radioisotopes on MOEE's Priority Pollutant List	22
17.4	Recommendation for a Cost Comparative Analysis	22
17.5	Recommendation for Assessment of Tritium Emission Control Strategies	22
17.6	Recommendation for Timely, Regular Public Reporting of Tritium Levels	22
17.7	Recommendation for Timely Reporting of Tritium Pulses	23
17.8	Recommendation to Initiate Discussions with Nuclear Facilities to Reduce Tritium Emissions	23
17.9	Recommendation to Improve Public Access to Drinking Water Survey Information	24
17.10	Recommendation for Radiation Health Studies and Involvement by Community Representatives in Planning	24
BIBLIOGRAPHY		26
APPENDIX A:	GLOSSARY	29
APPENDIX B:	LONG TERM VS SHORT TERM EXPOSURE TO RADIONUCLIDES	33
APPENDIX C:	REMOVAL OF TRITIUM FROM DRINKING WATER: TREATMENT OPTIONS	34
APPENDIX D:	ANALYSIS OF TRITIUM IN DRINKING WATER	35

TABLE OF CONTENTS

APPENDIX E.1: DRINKING WATER SURVEILLANCE PROGRAM - TRITIUM DATA

APPENDIX E.2: TRITIUM DATA - NUCLEAR SURVEILLANCE PROGRAM

APPENDIX E.3: TRITIUM DATA - TIME SERIES GRAPHS

APPENDIX F: LETTERS TO MINISTER OF HEALTH CANADA & MINISTER OF NATURAL RESOURCES CANADA

EXECUTIVE SUMMARY

In response to the recommendations of the Environmental Assessment Advisory Committee on the need for an individual environmental assessment on the proposed Pickering/Ajax Water Supply Plant, the Ministry of Environment and Energy requested that the Advisory Committee on Environmental Standards (ACES) carry out a public review and advise the Minister on an appropriate standard for tritium in drinking water.

In order to assist in the public review of the Ontario Drinking Water Objective (ODWO) for tritium, this document has been prepared by the Standards Development Branch of the Ministry. The report summarizes the process by which the current ODWO for tritium of 40,000 becquerels per litre (Bq/L) was established, gives an overview of the pertinent information that has become available since the ODWO was established and provides the rationale for recommending an interim Ontario Drinking Water Objective of 7,000 Bq/L for tritium. The interim objective will be applied as a health-related maximum acceptable concentration. It is recommended that the interim ODWO of 7,000 Bq/L replace the current ODWO and that it be reexamined once the review of the Canadian Drinking Water Guideline for tritium is complete.

A reassessment of the human health effects of ionizing radiation has been conducted by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the Committee on the Biological Effects of Ionizing Radiation (BEIR) of the United States National Research Council, the International Commission on Radiological Protection (ICRP) and the United States National Council on Radiation Protection and Measurements (NCRP). These scientific criteria documents are available for public review as a separate attachment to this report.

PART I RATIONALE FOR THE DEVELOPMENT OF AN INTERIM DRINKING WATER OBJECTIVE FOR TRITIUM

1.0 BACKGROUND

In order to address the need for additional water supply to the Pickering/Ajax area of Ontario, the Region of Durham in 1990 approved a recommendation to build a new, larger water treatment plant at the same location as the existing water supply plant.

In 1992 the Minister of the Environment asked the Environmental Assessment Advisory Committee for its advice on whether an individual environmental assessment should be required for the proposed water supply plant.

In its report to the Minister, the Environmental Assessment Advisory Committee recommended against an individual environmental assessment for the proposed plant provided that certain recommendations were appropriately addressed.

With respect to concerns raised about radionuclide concentrations in drinking water, the Committee recommended that the Minister "request her Advisory Committee on Environmental Standards (ACES) to carry out a public review and advise the Minister by the end of 1993 on an appropriate standard for tritium in drinking water". In addition, "the effects of long-term exposure to low levels of radionuclides and of short-term exposure to sudden elevated levels in drinking water" should also be addressed.

The following documentation is provided by the Ministry of Environment and Energy in order to assist in the public review of the current Ontario Drinking Water Objective for tritium.

2.0 INTRODUCTION

The current Ontario Drinking Water Objectives (ODWOs) for radionuclides, including tritium, were adopted from the Canadian Drinking Water Guidelines (CDWGs). The CDWGs are developed through a formal Federal-Provincial process involving representatives from each of the Provinces and Territories, in addition to representatives from Health & Welfare Canada and Environment Canada.

The current CDWGs and ODWOs for radionuclides were based upon the findings and recommendations of the International Commission on Radiological Protection (ICRP) that were published in 1977.

The recommendations from the ICRP, which are primarily based upon the reports of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), have recently been revised to reflect the most up to date information on the effects of ionizing radiation (ICRP, 1990). The UNSCEAR and ICRP reports indicate that earlier reports underestimate the risk associated with radiation exposure. Most information on the effects of ionizing radiation on humans comes from the continuing assessment of the effects of the nuclear explosions at Nagasaki and Hiroshima, as well as from nuclear incidents such as the one at Chernobyl. In light of the revised recommendations from the ICRP, the World Health Organization (WHO) is currently revising its drinking water guidelines for radionuclides, and Canada is currently in the process of revising its CDWGs for radionuclides, including tritium.

This report summarizes the available information that is pertinent to revision of the Ontario Drinking Water Objective for tritium and proposes an interim ODWO for tritium. The rationale for the interim ODWO is based primarily on the information and recommendations provided by UNSCEAR, the ICRP, the

WHO and the U.S. National Research Council's Committee on the Biological Effects of Ionizing Radiations (BEIR). A glossary of radiological terms has been included in Appendix A.

3.0 THE PROPERTIES OF TRITIUM

Tritium is a radioactive isotope of hydrogen and has one proton and two neutrons. Through the process of beta decay, tritium emits ionizing radiation in the form of a beta particle, or electron. All ionizing radiation is considered to be carcinogenic to humans, with the risk of developing cancer being proportional to the dose to the individual.

Tritiated and non-tritiated (i.e., normal) water have similar chemical and physical properties, and the human senses of smell, touch and taste are unable to distinguish tritiated from normal water.

Tritium is a naturally occurring radionuclide and may also be produced as a by-product in water-cooled nuclear reactors. Tritium undergoes beta decay with a physical half-life of 12.3 years. The beta particles are emitted in a continuous spectrum of energy, with the maximum energy being 18.6 kiloelectron volts (keV) and the average energy being 5.7 keV. The beta particle emitted has a range of approximately 6 millimetres (mm) in air and 0.0052 mm in a unit density material, which means, for example, that it is incapable of penetrating the outer layer of human skin.

Tritium may be taken into the body by inhalation or absorption through the skin. Once taken in, it is assumed that tritiated water is uniformly distributed among all the soft tissues in the body. Ingested, tritiated water is believed to be completely and immediately absorbed from the gastrointestinal tract, mixing rapidly with the total body water. Once absorbed, the retention of tritiated water in the body is related to the natural turnover of body water,

which is related to water intake, etc. Typically, the retention half-life is estimated to be ten days, but considerable variation can occur due to factors such as ambient temperature and personal habits.

In the natural environment and in drinking water treatment plants, tritiated water cannot be readily distinguished from other water. Consequently, conventional water treatment is unlikely to reduce tritium levels that are present in raw water supplies (see Appendix C).

4.0 TRITIUM: SOURCES AND OCCURRENCE

Tritium may be produced naturally in the upper atmosphere through the bombardment of nitrogen with neutrons from cosmic rays. Consequently, low levels of naturally-formed tritium exist in rainwater and surface waters. It is estimated that 10^{15} Bq of tritium are produced annually by natural processes (UNSCEAR, 1988).

Tritium is also produced in nuclear explosions, and nuclear weapons testing is the source of most of the tritium in the global environment. Tritium may also be released into the environment in emissions from nuclear energy production facilities, in particular from CANDU type water-cooled reactors.

5.0 EXPOSURE TO IONIZING RADIATION

The most comprehensive source of information on the overall exposure of the population to ionizing radiation is the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

The 1988 UNSCEAR Report on Sources, Effects and Risks of Ionizing Radiation summarizes current knowledge on exposure to ionizing radiation.

5.1 Natural Sources of Radiation

Natural sources of radiation are, by far, the largest contributor to the overall exposure of the global population to ionizing radiation. Cosmic rays, gamma rays and naturally occurring radionuclides, such as the uranium-238 and thorium-232 decay series including radon, are believed to contribute more than 98% of the annual radiation dose (excluding medical exposure) to the population. UNSCEAR has estimated that the global average exposure to ionizing radiation from natural sources is 2.4 millisieverts (mSv) per year (see Appendix A for definitions of radiological terms).

A recent assessment of the average exposure of the U.S. population to ionizing radiation was made by the National Council on Radiation Protection and Measurements (NCRP, 1987). The NCRP estimated that annual exposure to natural background radiation in the U.S. exceeded the global average and totalled approximately 3 mSv per year. The increased exposure estimate is primarily due to exposure in homes to radon from natural geological sources.

5.2 Other Sources of Radiation

In addition to the natural sources of ionizing radiation, humans may also be exposed to radiation through medical procedures (e.g. diagnostic x-rays), occupational sources, environmental releases from nuclear power production etc. Estimated annual radiation exposures from various sources are summarized in Table 1. Radon, a naturally occurring radioactive gas, is the principal source of radiation exposure, whereas tritium in drinking water comprises less than .1% of the total annual exposure to radiation (BEIR, 1990).

Drinking water sources of radiation exposure are included under "consumer products" in this table.

Table 1 : Radiation Exposure from Various Sources

Source	Estimated Annual Exposure	
	mSv	% of Total Annual Exposure
Natural Sources	2.4[1] - 3.0[2]	82%
Medical Exposures a) x-rays b) Nuclear Medicine	 0.4 0.14	 11% 4%
Consumer Products (including food and drinking water)	0.10	3%
[1] UNSCEAR, 1988 [2] NCRP, 1987		

6.0 HEALTH EFFECTS OF IONIZING RADIATION

Current knowledge on the health effects of ionizing radiation is summarized in the 1990 Report of the Committee on the Biological Effects of Ionizing Radiations (BEIR V, 1990). This Committee was established by the National Research Council in the United States to update the assessment on radiation effects published in 1980 (BEIR III, 1980).

Acute exposure to high levels of ionizing radiation may cause severe damage to bone marrow, gastrointestinal mucosa and other rapidly proliferating tissue. The degree of damage is dependent upon the magnitude of the dose and the duration of exposure. Acute radiation exposure is associated with nuclear accidents or explosions and is not relevant to the issue of long-term exposure to low levels of radionuclides in water.

Low doses of radiation may cause adverse effects in the genes and chromosomes of living cells. Where reproductive cells are affected by radiation, mutations may occur and adverse effects may be manifested in offspring. Adverse heritable effects from radiation exposure have been demonstrated in the mouse, but have not as yet been clearly demonstrated in humans.

Exposure to radiation may also result in the development of cancer. The carcinogenic potential of ionizing radiation is affected by such factors as the duration of exposure, the type of radiation, and the sensitivity of the tissue or organ irradiated. Some radionuclides concentrate in certain tissues (e.g., radioiodine in the thyroid gland), while other radionuclides, such as tritium, have no specific target tissue and are distributed throughout the body.

In general, it is assumed that the risk of cancer is proportional to the effective dose, and there is no "threshold" dose below which a cancer may not occur.

6.1 Assessing the Effective Dose of Radiation

Different types of radiation differ in their ability to cause adverse biological effects, and body tissues and organs have varying sensitivities to radiation. Consequently, in order to assess the relative impact of radiation on various biological receptors, the international scientific community has developed a system of radiation and tissue weighting factors in order that different radiation exposures may be readily compared and assessed. Through this approach, the effective dose of different radiation exposure scenarios can be estimated.

In this report, the effective dose is expressed in sieverts or millisieverts (1 Sv = 1000 mSv) and the amount of radioactivity is measured in becquerels in accordance with the current international system of units.

6.2 Estimation of the Risk Associated with Exposure to Ionizing Radiation

Assessment of the risk associated with exposure to radiation is an ongoing international effort. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), and, in the United States, the National Research Council's Committee on the Biological Effects of Ionizing Radiations have prepared several comprehensive reports on the sources, effects and risks of ionizing radiation (UNSCEAR, 1988; UNSCEAR, 1986; UNSCEAR, 1982; BEIR V, 1990; BEIR III, 1980).

Both the UNSCEAR and BEIR reports focus primarily on information obtained from follow-up studies on the survivors of the Hiroshima and Nagasaki atomic explosions, as well as on studies of workers and patients exposed to ionizing radiation. Information available in the 1980s made it apparent that the radiation risk estimates that were available for the UNSCEAR, 1982 and BEIR III reports underestimated the risk associated with radiation exposure and required extensive revision. The UNSCEAR 1988 and BEIR V reports reflect this updated risk assessment.

The findings of the UNSCEAR and BEIR committees are used by international and national agencies as the basis for recommendations for radiation protection. The International Commission on Radiological Protection (ICRP), and the National Council on Radiation Protection and Measurements (NCRP) in the United States, for example, provide recommendations to regulatory authorities based on the information in the UNSCEAR and BEIR reports.

In 1990, the ICRP issued its revised recommendations for radiation protection (ICRP, 1990). Based upon available information, the ICRP has estimated that the risk of developing a fatal cancer for the general population from radiation exposure is 5×10^{-2} per sievert.

7.0 DRINKING WATER GUIDELINES FOR RADIONUCLIDES

7.1 World Health Organization Guidelines

In light of the additional information and recommendations that have been provided by the ICRP and UNSCEAR, the World Health Organization (WHO) is currently revising its recommendations with regard to radionuclides in drinking water.

In its new guidelines, the WHO recommends a reference level committed effective dose of 0.1 mSv from one year's consumption of drinking water, and notes that this dose represents less than 5% of the average annual effective dose attributable to natural background radiation (WHO Draft Guidelines). In calculating the reference level of dose, a water consumption estimate of 2 L per day for a year was assumed and the calculation was based on an adult's metabolism. The WHO states that the influence of age on metabolism, and variations in the consumption of drinking water, do not require modification of the reference level of dose as an appropriate margin of safety is provided in the calculations and the dose is based on a lifetime exposure.

For practical purposes, the reference level of dose needs to be expressed as an activity concentration of radionuclides in drinking water. Metabolic and dosimetric factors were considered in the development of dose conversion factors which relate a dose (in Sv) to the amount of radionuclide (in Bq) ingested.

The reference concentration of tritium that would correspond to the reference level of dose of 0.1 mSv was estimated by the WHO to be 7,800 Bq per litre(WHO, 1993, in press). The WHO applied dose-conversion factors that had been used by the National Radiological Protection Board of the United Kingdom (NRPB, 1991) in deriving the reference concentration for tritium.

This reference concentration of 7,800 Bq/L for tritium is based upon the cancer risk associated with radiation exposure. The calculated cancer risk associated with the committed effective dose of 0.1 mSv is approximately 5×10^{-6} (i.e., 5 fatal cancers per million people exposed). At this level of exposure, any cancers that may result from radionuclides in drinking water are not detectable or distinguishable from the normal cancer incidence. Cancers due to background radiation cannot be distinguished from other cancers and, since exposure to natural background radiation cannot be avoided, they are simply part of the natural cancer incidence.

7.2 Canadian Drinking Water Guidelines

The current Canadian Drinking Water Guidelines (CDWGs) for radionuclides, including tritium, are based primarily upon the information available in the 1970's from international sources including the ICRP and WHO.

The current CDWG for tritium is 40,000 Bq/L. Through Health & Welfare Canada, Canada has played an active role in the revision of the WHO guidelines. In light of the new information on radionuclides and the revision of the ICRP and WHO recommendations, the CDWGs for radionuclides are currently being reviewed and revised through a formal federal-provincial process and are expected to be finalized in mid to late 1995. The new CDWGs are expected to reflect the WHO's recommendation of a reference level committed effective dose of 0.1 mSv from one year's consumption of drinking water.

7.3 Ontario Drinking Water Objectives

Ontario participates in the formal federal-provincial process that establishes the CDWGs and normally adopts new and revised CDWGs as Ontario's objectives. The ODWO of 40,000 Bq/L is based upon the current CDWG for tritium.

Ontario has the perogative to establish ODWOs independently, where appropriate, and this document is in response to the Ministry of Environment and Energy's commitment to review the current tritium guideline by the end of 1993.

7.4 United States Environmental Protection Agency Limits

The current U.S. Environmental Protection Agency (EPA) drinking water limit for tritium is approximately 800 Bq/L. In 1991, the EPA published its revised radionuclide regulation containing a proposed tritium in drinking water limit of approximately 2300 Bq/L (U.S. EPA, 1991). That proposed regulation has not been finalized and is still under review.

An assessment of the rationale and policies supporting the proposed EPA standard for tritium is beyond the scope of this document.

7.5 Calculation of an Interim Ontario Drinking Water Objective for Tritium

Based upon the recommendations of the ICRP and WHO, an interim drinking water objective for tritium may be calculated as follows:

$$\text{Interim Objective Concentration} = \frac{0.1 \text{ mSv/yr}}{730 \text{ L/yr} \times \text{dose conversion factor (Sv/Bq)}}$$

where 730 L/yr is the annual consumption of drinking water (assuming 2.0 L/day)

0.1 mSv/yr is the permissible exposure to radionuclides from drinking water

dose conversion factor, as provided by the National Radiological Protection Board (NRPB, 1991) and by the WHO for tritium, = 1.8×10^{-11} (Sv/Bq)

Based upon the above, the interim objective concentration for tritium that would result in 0.1 mSv exposure per year from drinking water is approximately 7,600 Bq/L.

In its most recent publication (Publication 61), the ICRP applies a different dose conversion factor for tritium that, if substituted into the above calculation, would result in an interim objective concentration for tritium of approximately 6,850 Bq/L (ICRP, 1991). Since an evaluation of the different dose conversion factors is beyond the scope of this document, and taking into account the appropriateness of using just one significant digit when dealing with scientific estimates of this nature, it is proposed that the interim Ontario Drinking Water Objective for tritium be established at 7,000 Bq per litre.

Where more than one radionuclide is present in a drinking water supply, drinking water objective concentrations may need to be adjusted such that the total exposure from all radionuclides in a drinking water supply does not result in an average annual exposure in excess of the committed effective dose of 0.1 mSv/yr. The testing of drinking water supplies for radionuclides includes, in addition to testing for tritium, an assessment of the gross alpha and beta emissions from various radionuclides. Where significant alpha and/or beta activity is detected, it is necessary to identify the specific radionuclides involved, to measure their individual activity concentrations, and to determine the effective dose from each of these radionuclides by applying the appropriate dose conversion factors.

The committed effective dose from all radionuclides in drinking water should not exceed 0.1 mSv per year.

8.0 THE NATURE AND APPLICATION OF DRINKING WATER GUIDELINES

8.1 WHO Guidelines

The World Health Organization (WHO) first published Guidelines for Drinking Water Quality in 1984 (WHO, 1984). The guidelines were developed by the WHO to describe the quality of water that is suitable for drinking purposes

under all circumstances. As such, the WHO described the derived guideline values as follows:

a) A guideline value represents the concentration of a constituent that ensures an aesthetically pleasing water and does not result in any significant risk to the health of the consumer;

b) The quality of water defined by the WHO guidelines is such that it is suitable for human consumption and for all normal domestic purposes;

c) Exceedence of a guideline value should be considered a signal to investigate the course of the exceedence with the purpose of determining the appropriate remedial action, and to consult with public health authorities for advice;

d) The guidelines were derived to describe a quality of water that would be acceptable for, and would safeguard health during, lifelong consumption;

e) Short-term deviations above the guideline values do not necessarily mean the water is unfit for consumption. The amount by which, and the duration that, any guideline value can be exceeded without affecting public health depends upon the specific substance involved;

f) In the case of radioactive substances, the term guideline value is used in the sense of a "reference level", as defined by the ICRP, where a reference level is not specifically a limit but is a signal to pursue certain courses of action, such as investigation of the cause or implications of the elevated level; and

g) A value in excess of the guideline value does not in itself imply that the water is unsuitable for consumption.

8.2 Canadian Drinking Water Guideline (CDWGs)

The Guidelines for Canadian Drinking Water Quality (Health and Welfare, Canada, 1993(b)) indicate that the CDWGs are to be applied in a similar fashion to the WHO guidelines.

Similarly to the WHO, the CDWGs are intended to provide guidance as to the acceptability of drinking water supplies. The judicious use of the guidelines e.g., investigating exceedences, taking remedial action where appropriate, will result in drinking water that is protective of public health.

8.3 Ontario Drinking Water Objectives (ODWOs)

Ontario Drinking Water Objectives are applied in a similar fashion to the Canadian Drinking Water Guidelines. They provide guidance as to the acceptability of public drinking water supplies and water supplies that meet these objectives are protective of human health.

It should be noted that the assessment of the acceptability of a water supply during a specific nuclear emergency (e.g., a large spill of tritium) that may lead to significantly elevated tritium levels in drinking water supplies, is primarily the responsibility of the local Medical Officer of Health and the Ministry of the Solicitor General. Through Ontario's Nuclear Emergency Response Plan, the Ministry of the Solicitor General, in cooperation with public health authorities and other agencies, would coordinate the appropriate response to any nuclear accident.

9.0 TRITIUM IN DRINKING WATER IN ONTARIO

Through its Drinking Water Surveillance Program (DWSP), the Ontario Ministry of Environment and Energy now surveys more than 100 water supply systems annually for radionuclides and other contaminants in water. Both raw and treated water are analyzed. Tritium data from the DWSP are summarized in Appendix E.1 and have been updated to reflect data current to 1994.

In addition to DWSP, the MOEE also runs surveillance programs in the vicinity of nuclear generating stations in Ontario. Part of this nuclear surveillance program involves regular testing of water supplies at nearby water treatment plants. Drinking water data for tritium from this program for the period between December 1988 - November 1994 (where available) is summarized in Appendix E.2.

All radionuclide analysis is conducted by the Ontario Ministry of Labour's Radiation Protection Laboratory. A brief description of the analytical method is given in Appendix D.

10.0 SOCIO-ECONOMIC IMPACT OF REVISED DRINKING WATER OBJECTIVE FOR TRITIUM

As summarized in Section 9.0 and Appendix E, the levels of tritium in drinking water supplies in Ontario rarely exceed 100 Bq/L on an instantaneous basis and has never been exceeded on an annual average basis. Consequently, revision of the current ODWO of 40,000 Bq/L to an interim ODWO of 7,000 Bq/L would not be anticipated to have any major socio-economic impact in normal situations.

In emergency situations (e.g., spill of nuclear material), the provincial response would be directed by the Ministry of the Solicitor General under its Nuclear

Emergency Plan for Ontario. Under this plan, the response of various Ministries (e.g., Ministry of Environment and Energy, Ministry of Labour, Ministry of Agriculture and Food, Ministry of Health) would be coordinated by the Ministry of the Solicitor General. Additional support and advice would be sought from Federal Departments such as Health & Welfare Canada, and guidance as to the acceptability of water supplies would be provided by the appropriate medical officer of health for the affected area. During an emergency situation, it may be necessary to consider other sources of exposure (e.g., contaminated food) in addition to drinking water, and the duration of exposure would also need to be considered. Consequently, emergency response guidance would be provided on a case-by-case basis, and assessment of the socio-economic impact of such an event is beyond the scope of this document.

11.0 PROPOSED INTERIM DRINKING WATER OBJECTIVE FOR TRITIUM

For the reasons provided in this report, it is recommended that the current ODWO of 40,000 becquerels/litre for tritium be replaced by an interim ODWO for tritium of 7,000 becquerels per litre. This interim objective is a health-related maximum acceptable concentration and should be applied as such until the CDWGs for radionuclides, including tritium, are revised. Once the CDWGs for radionuclides are revised, this interim objective should be reviewed.

PART II CONSIDERATION OF ISSUES AND THE ADVISORY COMMITTEE ON ENVIRONMENTAL STANDARDS' RECOMMENDATIONS

12.0 STAKEHOLDERS VIEWS ON THE ACES RECOMMENDATIONS

In identifying the key issues and concerns related to ACES' recommendations, Ministry staff conducted focussed consultation with stakeholders both internal and external to the Ministry of Environment and Energy. Within the Ontario government, Ministries' of Health, Labour, Solicitor-General and the Ontario Clean Water Agency were consulted. Federal regulators included Health Canada and the Atomic Energy Control Board. Input was also received from ACES, Ontario Hydro, Atomic Energy Canada Ltd., Energy Probe, Durham Nuclear Awareness, Ajax Save the Waterfront, Power Worker's Union, and Medical Officers of Health for the Region of Durham.

In addition, approximately 155 unsolicited letters to the Minister, including position papers and detailed submissions by interest groups and industry organizations were considered.

13.0 CURRENT EXPOSURES TO TRITIUM AND OTHER RADIONUCLIDES IN DRINKING WATER

The original Rationale Document (1993) provided a limited information on the levels of tritium measured in Ontario's drinking water. With this update, additional results on the levels of tritium monitored at water treatment plants near Ontario's nuclear facilities are included (Appendix E). Source data has been provided by the Ministry of Labour's Radiation Protection Service Laboratory, and covers the period between December 1988 to November 1994, where available (Appendix E2).

The Ministry of Labour currently analyses weekly and monthly composite samples of tritium as part of the Ministry of Environment and Energy's radiological survey. Other radionuclides monitored in conjunction with tritium are cesium-134, cesium-137, iodine-131, cobalt-60. For the period 1989 - 1994, levels of these 4 other radionuclides have not been detected above the detection limit of 0.3 Bq/L.

Gross alpha and beta determinations are also routinely performed on all sampled water treatment plants except for Lakeview and Lorne Park. Gross alpha and beta testing are not capable of detecting low levels of tritium. However, the determinations do give a general indication of other possible radionuclides present in water. For the period 1989 - 1994, average gross beta levels have ranged from 0.05 - 0.17 Bq/L with maximums ranging from 0.08 - 1.1 Bq/L. Gross alpha levels averaged 0.03 Bq/L with maximums ranging from 0.04 - 0.40 Bq/L.

Results of tritium monitoring data indicate current levels in Ontario's drinking water to be well below the new interim objective. Drinking Water Surveillance Program data on tritium at over 100 different locations suggest background levels (i.e remote from nuclear facilities) in drinking water to be generally below the detection limit range of 6 Bq/L to 11 Bq/L (Appendix E1). Historical results of weekly and monthly tritium samples taken at water treatment plants near nuclear facilities have shown a steady decline in tritium levels. Results indicate annual average tritium concentrations at each of the water treatment plants have consistently remained below 100 Bq/L (Appendix E2).

Maintaining their standard to keep the public's exposure as low as reasonably achievable, Ontario Hydro has committed to ensure tritium levels in drinking water near their facilities continue to stay below 100 Bq/L on an annual average basis, and will be publicly reporting on their performance.

14.0 RADIONUCLIDE MAXIMUM ACCEPTABLE CONCENTRATION (MAC)

In general, Ontario's Drinking Water Objectives are used to assess the long term acceptability of drinking water supplies, and are considered to be the minimum level of water quality suitable for human consumption. When an ODWO is established above background levels, as in the case with tritium, it does not mean that source water can be degraded or contaminated up to the objective level. MOEE policy is to reduce contaminant levels to the greatest extent possible. The ODWO is a maximum acceptable concentration (MAC) NOT a desirable water quality objective.

In the case of a radionuclide maximum acceptable concentration (MAC), the application of the MAC is only valid when there is just one radionuclide present in the drinking water. Otherwise, a restriction for multiple radionuclides must be met which takes into account the contribution from other radionuclides. From the current monitoring results, it would appear that only tritium is routinely detected in drinking water and the contribution from other radionuclides in drinking water is small. Overall, Ontarians are exposed to low levels of radionuclides, including tritium in drinking water.

15.0 ACES RECOMMENDATIONS REFERRED TO THE FEDERAL AGENCIES

ACES' proposed tritium objectives were based on different risk levels than those traditionally used by federal and international regulatory agencies in radiation protection. The ACES' rationale has raised the issue that there are differences in risk approaches to setting standards for radionuclides as compared to industrial chemicals. Chemical and radiation standards have different regulatory applications and have developed along two separate paths. The lack of consensus on acceptable risk levels has resulted in widely differing standards amongst regulatory agencies.

In recognition that the differences in risk approaches is a matter of considerable debate and scope, the Minister has requested the cooperation of federal regulators at Health Canada and Natural Resources to consider the issues raised by ACES.

The federal Department of Natural Resources, through the Atomic Energy Control Board (AECB), is responsible for licensing nuclear facilities and for regulating radioactive emissions. The Minister has urged the AECB to reduce the allowable public exposure from all radioactive emissions released from nuclear facilities. Currently, the allowable public exposure limit used by the AECB in deriving maximum emission limits for nuclear facilities is 5 mSv/yr. The AECB has proposed a reduction in the public dose limit to 1 mSv/yr consistent with ICRP's 1990 recommendations. The AECB's derived emission limit (DEL) is a legally enforceable *effluent limit* for contaminants in wastewater and applies to a nuclear facility at the point of discharge. It is distinctly different from a drinking water objective which applies specifically to water works that supply treated water for domestic and household purposes - i.e water treatment plant.

The federal government, in addition to their regulatory jurisdiction over nuclear matters, provides the human health assessment in the development of drinking water guidelines. Health Canada has developed supporting documentation for proposed revisions to the Canadian Drinking Water Guidelines for radionuclides. The documentation is currently being reviewed through a federal-provincial process. The Minister has formally submitted the ACES report and recommendations to Health Canada for consideration in the ongoing federal-provincial review of the Canadian Drinking Water Guidelines for radionuclides.

16.0 DECISION ON ONTARIO'S NEW DRINKING WATER OBJECTIVE FOR TRITIUM

The Minister of Environment and Energy announced on December 22, 1994 the establishment of a new Ontario Drinking Water Objective (ODWO) for tritium of 7000 Bq/L. The objective is to be applied as a health-related maximum acceptable concentration. The drinking water objective for tritium is interim until the revisions to the Canadian Drinking Water Guidelines for radionuclides and the review of risk approaches for chemicals and radionuclides are completed.

17.0 RESPONSE TO OTHER ACES'S RECOMMENDATIONS

17.1 Recommendation for a Multi-Media Approach

MOEE concurs that the multimedia approach is the best way to proceed and that other jurisdictions, especially Health Canada and the Atomic Energy Control Board (AECB) have the prime responsibility. The ACES' recommendations have been referred to the federal government for action. A multi-media approach is used by Health Canada in developing drinking water guidelines, and in the case of radionuclides, exposure to all radionuclides are controlled under a single allowable public dose, providing even greater public health protection, when multiple radionuclides are present. The AECB also uses the multi-pathway, multiple radionuclide approach to limit total exposure in licensing nuclear facilities.

17.2 Recommendation for a MOEE Policy on Risk Estimation

MOEE's Standards Development Branch is developing over the next year, a standard setting framework policy and protocols to be used for all media and receptors. Staff are consulting with ACES in developing the policy.

17.3 Recommendation for Placement of Toxic, Persistent Radioisotopes on MOEE's Priority Pollutant List.

The ministry has no plans at present to do further revisions to our Priority Pollutant List. Radionuclides would not be included because of the federal government's leadership responsibilities in this area.

17.4 Recommendation for a Comparative Cost Analysis

An evaluation of costs was carried out prior to the Minister's decision on the new interim tritium drinking water objective of 7000 Bq/L.

17.5 Recommendation for Assessment of Tritium Emission Control Strategies

It is the responsibility of the Atomic Energy Control Board to evaluate the need for additional tritium control strategies.

17.6 Recommendation for Timely, Regular and Public Reporting of Tritium Levels

Ontario Hydro will report publicly and submit to the Minister, on a quarterly basis, the results of rolling annual tritium averages to ensure tritium levels at water treatment plants near their facilities, remain below 100 Bq/L on an annual average basis.

Nuclear facilities are already required to regularly monitor their effluents and report their findings to the federal Atomic Energy Control Board (AECB) on a quarterly basis. This information is publicly available from the AECB.

Summary reports of radiological monitoring data are published annually by nuclear facilities as a license requirement of the AECB. The reports contain monitoring data collected from wastewater effluents and at water treatment

plants, and provide an analysis and estimate of the radiation dose received by the public as a result of the plants' operations.

Data collected under the Nuclear Surveillance Program are reported in MOEE's Annual Survey of Radiological Data. Twenty water treatment plants near nuclear facilities are routinely monitored for tritium and other radionuclides. Analysis is done on either weekly or monthly composites water samples. The composite sample is composed of equal quantities of water collected each day over the sampling period. This approach provides a much better measure of total exposure as compared to taking a single sample during the sampling period. As of July 1994, analysis of the composite sample at the Port Elgin and Kincardine water treatment plants has increased to a weekly frequency from monthly.

17.7 Recommendation for Timely Reporting of Tritium Pulses

Federal health experts have indicated that there are no known extra radiation health risks associated with low pulse doses, rather the risks are associated with cumulative exposures over the longer term. Monitoring programmes in place measure these exposures. In the case of an accidental spill or tritium release which might result in exposures above the drinking water objective, health officials and water treatment plants are notified by the nuclear facility, so necessary precautionary procedures to limit public exposure are taken.

17.8 Recommendation to Initiate Discussion with Nuclear Facilities to Reduce Tritium Emissions

Discussions with Ontario Hydro has resulted in their public commitment to keep levels of tritium in drinking water near their facilities, below 100 Bq/L on an annual basis.

17.9 Recommendation to Improve Public Access to Drinking Water Survey Information

The Ministry of Labour's radiological drinking water data is reported in MOEE's Annual Survey of Radiological Data. However, because the report is a compilation of unaudited data with no interpretation, it is for reference purposes only and is not intended for public release.

Drinking Water Surveillance Program (DWSP) reports are published every 2 years and are released to the general public. Under the program, chemical and radionuclide parameters are monitored on a frequency of 2 to 8 times per year.

Discussions are underway to coordinate and improve the public reporting aspect of the two programs.

17.10 Recommendation for Radiation Health Studies and Involvement by Community Representatives in Planning

These recommendations are similar to the Environmental Assessment Advisory Committee's (EAAC) recommendation in 1992 for the establishment of a Durham Nuclear Health Committee (DNHC). The committee would provide a forum to address concerns about the health effects of low level ionizing radiation reaching the public via all pathways as a result of nuclear plant operations.

The ministry is supportive of the EAAC recommendation to establish the DNHC, if it is also supported by the citizens of Durham Region.

The Chair of the Health and Social Service Committee of Durham Region has expressed his support for the Committee in terms of providing the venue for

meetings and to offer the Regional Medical Officer of Health as Committee Chair. Ontario Hydro has agreed to provide resources in the form of administrative and secretarial support to the Committee, to pay out-of-pocket expenses for citizen and NGO members to attend meetings. Hydro is also prepared to commit resources to making available all relevant research studies, to reformat technical material as necessary to make it more understandable to Committee members, and to work with the Committee to identify areas in which further studies may be needed.

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APPENDIX A

GLOSSARY

APPENDIX A : GLOSSARY

Absorbed Dose

The mean energy imparted by ionizing radiation to an irradiated medium per unit mass. The international unit for absorbed dose is the gray (Gy). Absorbed dose was previously expressed in rads (Radiation Absorbed Dose) where 1 rad equals 0.01 Gy.

Activity

The rate of decay (i.e., number of disintegrations or transformations per unit time) of a radioactive nuclide. The international unit of activity is the becquerel (Bq).

Alpha Particles

Fast moving helium nuclei (consisting of two protons and two neutrons) that are emitted from certain radioactive isotopes during decay or disintegration. Alpha particles are densely ionizing with little penetrating power.

Background Radiation

The amount of radiation to which a member of the population is exposed from natural sources including terrestrial radiation due to naturally occurring radionuclides in the soil and cosmic radiation originating in outer space.

Beta Particles

Fast moving electrons ejected from the nuclei of certain unstable radioactive atoms (e.g. tritium). Beta particles are not densely ionizing.

BEIR

The U.S. National Research Council's Committee on Biological Effects of Ionizing Radiation.

Becquerel (Bq)

International unit of measurement of the activity of a radioactive nuclide. One becquerel corresponds to one atomic transformation or disintegration per second and is equivalent to 2.7×10^{-11} Curies.

Carcinogen

An agent that may cause cancer. Ionizing radiation is a carcinogen.

Committed Effective Dose

The time integral of the effective dose, where the integration time is usually 50 years.

Curie (Ci)

A unit of activity equal to 3.7×10^{10} disintegrations per second.

Dose Equivalent

A measurement that relates absorbed dose with the biological effectiveness (i.e. probability of causing biological damage) of all kinds of ionizing radiation. Dose equivalents are calculated by multiplying the absorbed dose by a quality factor that accounts for differences between different types of radiation. The international unit of dose equivalents is the sievert (Sv).

Effective Dose Equivalent

A measurement that relates the absorbed dose and dose equivalent to the risk of biological damage, taking into account the varying degrees of sensitivity of particular tissues and organs to radiation damage. In order to assess effective dose equivalents, tissue weighting factors have been developed by organizations such as the ICRP.

Gamma Rays

Short-wave electromagnetic radiation that is not densely ionizing but possesses high penetrating ability. It can easily penetrate and pass through a human body. Used in certain medical procedures (e.g. cancer therapy), they are more energetic than x-rays.

Gray

The international unit of absorbed dose where one gray equals one joule per kilogram, and one gray equals 100 rad.

ICRP

International Commission on Radiation Protection

Ionizing Radiation

Radiation that is capable of producing ions (particles with an electric charge) by dislodging electrons from an atom.

Maximum Acceptable Concentration (MAC)

A MAC is a type of Drinking Water Objective that is established for certain substances that are known or suspected to cause adverse effects on health. Each MAC has been derived to safeguard health assuming lifelong consumption of drinking water containing the substance at that concentration.

Drinking water that continually contains a substance at a level greater than its MAC will contribute significantly to consumers' exposure to the substance and may, in some instances, induce deleterious effects on health. However, short-term excursions above the MAC do not necessarily mean that the water constitutes an undue risk to health. The amount by which, and the period for which, the MAC can be exceeded without posing a health risk must be assessed by taking into account the toxicity of the substance involved.

Neutron Radiation

Neutrons are uncharged subatomic particles that are capable of producing ionization in matter by collision with charged particles. One of the sources of neutron radiation is the fission process in nuclear reactors and this is often used to create radioactive isotopes.

Rad

A unit of absorbed dose, now replaced in international units by the gray, where one rad equals 100 erg/g, which equals 0.01 gray.

Radioactivity

The spontaneous emission of radiation, in the form of alpha particles, beta particles etc.

Relative Biological Effectiveness

The biological potency of one type of radiation as compared with another to produce equivalent biological damage.

Rem

A measure of dose equivalent (1 rem = 0.01 Sv).

Sievert

The international unit of dose equivalents, equal to 100 rem or 1000 millisieverts.

UNSCEAR

United Nations Scientific Committee on the Effects of Atomic Radiation. UNSCEAR publishes periodic reports on sources and effects of ionizing radiation.

X-Rays

Penetrating electromagnetic radiation that is artificially produced by specific devices. X-rays resemble gamma rays but are less energetic.

APPENDIX B:

LONG-TERM VS SHORT-TERM EXPOSURE TO RADIONUCLIDES

As part of the recommendation from the Environmental Assessment Advisory Board to the Minister of Environment (and Energy) to review the guideline for tritium in drinking water, the Ministry was also requested to address the issue of the effects of long-term exposure to low levels of radionuclides and of short-term exposure to sudden elevated levels in drinking water.

The proposed interim drinking water objective for tritium of 7000 Bq/L addresses the issue of long-term exposure to low levels of radionuclides. Drinking water containing 7000 Bq/L of tritium would lead to an annual exposure of 0.1 mSv, approximately 4% of the annual background exposure to radiation in Ontario. Exposure to 1000 mSv of radiation at one time might result in nausea and vomiting in the short term, but such exposures would not be encountered in drinking water supplies, (i.e., in order to be exposed to 1000 mSv of radiation from tritium in a day, assuming 2 L of water is consumed, the tritium concentration in the drinking water would need to be approximately 2.8×10^{10} Bq/L (or 28 billion becquerels/L).

APPENDIX C:

REMOVAL OF TRITIUM FROM DRINKING WATER - TREATMENT OPTIONS

Very little information is available on the efficacy of various water treatment processes with regard to the removal of tritium from water supplies.

Conventional treatment (e.g., coagulation/sedimentation) is believed to be of limited effectiveness for the removal of tritium from water (Health & Welfare Canada, 1993(a)).

While air stripping, adsorption and ion exchange technologies may be effective technologies for the removal of tritium, these technologies have not been adequately assessed with respect to tritium removal (Health & Welfare Canada, 1993(a)). Consequently, the U.S. Environmental Protection Agency recommends the use of alternate water supplies (including bottled water) when drinking water supplies are excessively contaminated with tritium (Federal Register, V.56, No. 138; July 18, 1991).

APPENDIX D:

ANALYSIS OF TRITIUM IN DRINKING WATER

The analysis of tritium in drinking water is conducted by the Radiation Protection Service Laboratory (RPSL) of the Ontario Ministry of Labour.

The procedure used for the determination of tritium in water begins with the distillation of the samples. The middle fraction of the distillate is combined with a liquid scintillation cocktail and counted in a Liquid Scintillation Counter. Normal reported detection limits are approximately 7 Bq per litre.

APPENDIX E.1

TRITIUM DATA

DRINKING WATER SURVEILLANCE PROGRAM

APPENDIX E.1:

DRINKING WATER SURVEILLANCE PROGRAM
Tritium (Bq/L) Detected in Drinking Water Supplies
Period: 1991 - 1994

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
AJAX WTP	12-Mar-91	130	30
	12-May-92	16	12
	Nov-93	9	12
	Feb-94	13	15
ALEXANDRIA WTP	28-Sep-92	< 7 (a)	< 7
	Apr-93	< 6	< 6
	Jan-94	< 6	< 6
ALVINSTON WTP	18-Feb-91	< 9	< 9
	19-Aug-91	<10	<10
	21-Oct-91	< 9	< 9
	22-Jun-92	< 7	< 7
	Feb-93	< 6	< 6
	Mar-93	< 6	< 6
AMHERSTBURG WSS	18-Mar-91	< 9	
	20-Mar-91		10
	16-Sep-91	<10	<10
	16-Mar-92	< 9	
	18-Mar-92		< 9
	22-Sep-92	< 7	
	24-Sep-92		< 7
	Jan-93	9	< 6
	Jan-94	< 6	< 6
ATIKOKAN WTP	26-Mar-91	<11	<11
	23-Sep-91	8	10
	23-Mar-92	< 9	< 9
	25-May-92	< 6	7
	Jan-93	< 6	< 6
	Jan-94	< 6	< 6

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
AURORA WELL SUPPLY Well 3	May-94		< 6
Well 4	May-94		< 6
BARRIE WELL SUPPLY Centennial 12	Sept-93		< 6
	Apr-94	< 6	< 6
COWAN	Sept-93	< 6	
	Apr-94		< 6
HERITAGE 11	Mar-94		< 6
HERITAGE 14	Nov-93		< 6
	Mar-94		< 6
HURONIA	May-94		< 6
JOHN STREET	Sept-93	< 6	
	Apr-94	< 6	
JOHNSON 13	May-94		< 6
JOHNSON 9	May-94		< 6
MARY	Nov-93		< 6
PERRY	Mar-94		< 6
TIFFEN WELL	Nov-93	< 6	
	Mar-94	< 6	
TOLLENDALE	Nov-93		< 6
	Mar-94		< 6
WOOD	Sept-93	< 6	
	Apr-94	< 6	
BEARDMORE	Feb-93	< 6	< 6
	Aug-93	< 6	< 6
BEAVERTON WTP	18-Feb-92	< 9	< 9
	June-93	7	8
BELLE RIVER WTP	18-Feb-91	< 9	< 9
	16-Sep-91	<10	<10
	21-Apr-92	55	< 8
	Feb-93	6	10
	Apr-94	< 6	< 6

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
BELLEVILLE WTP	02-Jul-91	<10	<10
	04-Nov-91	< 9	< 9
	06-Apr-92	< 9	< 9
	Apr-93	< 6	< 6
	Apr-94	< 6	< 6
BLEZARD VALLEY Lindon Drive	June-94		< 6
Michelle Street	June-94		< 6
Philippe Street	June-94		< 6
BRACEBRIDGE LEADER SPRING	23-Sep-91	14	10
	Sept-93	< 6	
Standpipe	Sept-93	< 6	
BRACEBRIDGE WTP	23-Sep-91	< 8	8
	24-Feb-92	< 9	< 9
	25-May-92		7
BRANTFORD WTP	25-Feb-91	11	9
	26-Aug-91		<20
	23-Sep-91		< 8
	25-May-92	9	7
	Mar-93	< 6	< 6
	Sept-94	< 6	< 6
BROCKVILLE WTP	19-Feb-91	9	< 9
	17-Sep-91	<10	<10
	21-Apr-92	22	12
	Jan-93	12	6
	Jan-94	11	9
BURLINGTON WTP	04-Feb-91	11	15
	06-Aug-91	<10	13
	07-Oct-91	12	15
	01-Jun-92	15	12
	Mar-93	10	15
	Mar-94	< 6	12
CAMBRIDGE WELL SUPPLY(G3,MIDDLETON ST)	21-Jan-92	< 9	10

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
G1	Aug-93	< 6	
G3	Oct-94		< 6
G9	Aug-93	< 6	
	Oct-94		< 6
MIDDLETON RESERVOIR	Aug-93	< 6	
	Oct-94		< 6
ST. ANDREWS TOWER	Oct-94		< 6
CAPREOL WELL SUPPLY (CAPREOL 6)	Sept-93	< 6	
CASSELMAN WTP	04-Feb-91	18	<16
	03-Sep-91	<10	<10
	06-Apr-92	< 9	< 9
	Apr-93	< 6	
	June-94		< 6
	Apr-93	< 6	
	June-94		< 6
CAYUGA WTP	04-Mar-91	< 9	< 9
	05-Sep-91	9	< 8
	04-May-92	< 8	< 8
	Jan-93	< 6	
	July-94		< 6
	Jan-93	< 6	
	July-94		< 6
CHAPLEAU WTP	18-Apr-91	<11	<11
	23-Sep-91	< 8	< 8
	03-Dec-91	< 8	
	24-Feb-92	< 9	< 9
	28-Sep-92	< 7	< 7
CHAPLEAU WTP - LOWLIFT PUMP	May-93	< 6	
CHAPLEAU WTP - HIGHLIFT DISCHARGE	May-93	< 6	
CHARLOTTENBURG WTP	19-Jun-91	15	<10
	22-Oct-91	< 9	< 9
	21-Jan-92	< 9	< 9
	18-Aug-92	9	11

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
	Feb-93	11	9
	Feb-94	< 6	< 6
CHATHAM WTP	04-Feb-91	<12	
	05-Feb-91		12
	06-Aug-91	<11	
	07-Aug-91		<11
	June-93	< 6	8
	Apr-94	< 6	< 6
COBOURG WTP	21-Oct-91	< 9	< 9
	Feb-93	13	11
	May-94	< 6	< 6
COCHENOUR WTP	Sept-94	< 6	< 6
COLLINGWOOD WTP	June-94	< 6	< 6
CORNWALL WTP	18-Mar-91	10	10
	23-Sep-91	8	11
	21-Sep-92	< 7	< 7
	Sept-93	< 6	9
	Jun-94	< 6	< 6
DELHI SPRING SUPPLY	04-Mar-91	< 9	< 9
	07-Oct-91	< 8	
	06-Jan-92	< 8	< 8
	08-Sep-92	< 7	< 7
DELHI WTP	04-Mar-91	< 8	< 8
	07-Oct-91	< 8	< 8
	06-Jan-92	< 8	< 8
	06-Jul-92	< 7	< 7
DELHI SPRING RAW WATER	May-93	< 6	< 6
DELHI WTP	Jan-93	< 6	< 6
DELHI DISTRIBUTION MAIN	Jan-93	< 6	
	May-94		< 6
DESERONTO WTP	06-Aug-91	11	<11
	04-Nov-91	9	< 9
	02-Mar-92	9	< 9

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
DESERONTO RAW LAB TAP	Sept-93	8	< 6
	Sept-94	< 6	< 6
DORCHESTER WELL SUPPLY FIELD WELL 1	Feb-93	< 6	
FIELD WELL 3	Feb-93	< 6	
FIELD WELL 4	Feb-93	< 6	
HIGHLIFT 1	Feb-93	< 6	
	July-94		< 6
RESERVOIR	Feb-93	< 6	
	July-94		< 6
DOWLING WELL SUPPLY - LIONEL WELL	July-94		< 6
RIVERSIDE WELL	July-94		< 6
DRESDEN WTP	11-Feb-91	9	9
	10-Jun-91	10	<10
	12-Aug-91	<11	12
	04-May-92	< 8	< 8
	Oct-93	7	< 6
	Aug-94	< 6	< 6
DRYDEN WTP	25-Mar-91	<11	<11
	27-Jan-92	< 8	< 8
	Apr-93	< 6	< 6
	Jan-94	< 6	< 6
DUNNVILLE WSS (INDUSTRIAL WATER)	12-Aug-91	<10	
	08-Jun-92	10	
DUNNVILLE (INDUSTRIAL) LOWLIFT WET WELL	Mar-93	< 6	
DUNNVILLE WTP	11-Feb-91	<16	16
	12-Aug-91	<10	<10
	08-Jun-92	6	< 6
	Apr-93	< 6	
	Jan-94		< 6
HIGHLIFT DISCHARGE	Mar-93	< 6	
	June-94		< 6

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
EAR FALLS WTP LOWLIFT DISCHARGE	Apr-93	< 6	
	June-94		< 6
HIGHLIFT DISCHARGE	Mar-93		< 6
	June-94	< 6	
ELMIRA WELL SUPPLY ELMIRA E6 RAW	Apr-93	< 6	
ELMIRA WATER TOWER	Apr-93	< 6	
EMO WTP	10-Jun-91	<10	<10
	16-Jul-91	<11	<11
	12-Nov-91	< 8	
	13-Nov-91		< 8
	10-Feb-92	< 9	
	11-Feb-92		< 9
	13-Oct-92	< 7	
	14-Oct-92		< 7
EMO WTP LOWLIFT DISCHARGE	May-93	< 6	
	Apr-94		< 6
HIGHLIFT DISCHARGE	May-93	< 6	
	July-94		< 6
FORT ERIE (ROSEHILL) WTP	10-Jun-91	<10	<10
	07-Oct-91	10	10
	09-Mar-92	< 9	< 9
	Mar-93	< 6	
	Sept.-94	4	
	Mar-93		< 6
	Sept.-94		3
FORT FRANCES WTP	25-Feb-91	< 8	< 8
	28-Sep-92	< 7	< 7
LOWLIFT DISCHARGE	Mar-93	< 6	
	Sept.-94		6
HIGHLIFT DISCHARGE	June-93	< 6	
	Feb-94		< 6

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
GODERICH WTP	06-Apr-92	< 8	< 9
	08-Sep-92	< 7	< 7
LOWLIFT DISCHARGE	Mar-94		8
HIGHLIFT DISCHARGE	Mar-94		7
GRAVENHURST WTP	18-Mar-91	10	9
	16-Sep-91	<10	<10
	21-Oct-91	< 9	< 9
	17-Feb-92	< 9	< 9
LOWLIFT DISCHARGE	Mar-93	< 6	
	June-94		< 6
HIGHLIFT DISCHARGE	Apr-93		11
	Jan-94	8	
GRIMSBY WTP	18-Nov-91	< 8	11
	21-Apr-92	12	< 8
RAW TAP	Apr-93		11
	Jan-94	8	
TREATED TAP	Apr-93	< 6	
	Jan-94		8
GUELPH WELL SUPPLY 6 WELL ARKEL SPRINGS	Aug-93	< 6	
7 WELL ARKEL SPRINGS	Aug-93	< 6	
8 WELL ARKEL SPRINGS	Aug-93	< 6	
BURKES	Oct-93 Oct-94	9 < 6	
CALICO	Oct-93	< 6	
CARTER	Aug-93	< 6	
CLYTHE	Aug-93	< 6	
DEAN	Nov-93	< 6	
DOWNEY	Oct-93	< 6	
EDINBURGH ROAD	Nov-93	7	
EMMA STREET	Nov-93	< 6	
HELMAR	Oct-93 Oct-94	< 6	< 6
MEMBRO WELL	Aug-93	< 6	

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
PAISLEY WELL	Oct-93	7	
PAISLEY WELL	Oct-94		< 6
PARK	Oct-93	6	
	Oct-94		< 6
QUEENSDALE	Oct-93	< 6	
	Oct-94		< 6
SACCO	Nov-93	< 6	
SILVERCREEK	Aug-93	< 6	
SMALLFIELD	Nov-93	< 6	
UNIVERSITY WELL	Nov-93	< 6	
WATER STREET	Nov-93	< 6	
PAISLEY DISTRIBUTION	Oct-93	< 6	
UNIVERSITY DISTRIBUTION	Nov-93	< 6	
HALDIMAND/NORFOLK WSS	04-Feb-91	11	
	06-Feb-91		< 8
	03-Sep-91	<10	<10
	06-Apr-92	< 9	
	08-Apr-92		< 9
HALDIMAND-NORFOLK WSS	Apr-93	< 6	
FOREBAY	Apr-94		< 6
HIGHLIFT DISCHARGE	Apr-93	< 6	
	Apr-94		< 6
HAMILTON WSS	25-Nov-91	< 8	< 8
	22-Jun-92	12	9
HAMILTON WSS	June-93	13	
SUCTION WELL DISCHARGE	June-94		< 6
CLEAR WELL DISCHARGE	June-93	12	
	June-94		< 6
HARROW-COLCHESTER WSS	25-Mar-91	11	
	26-Mar-91		< 9
	27-Jan-92	9	
	28-Jan-92		< 8
HAWKESBURY WTP	11-Feb-91	<18	<18
	12-Nov-91	9	9
	13-Apr-92	9	< 8

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
HAWKESBURY WTP LOWLIFT	Oct-93 Apr-94	14	 < 6
HIGHLIFT PUMP	Oct-93 Apr-94	8	 < 6
HUNTSVILLE WTP LOWLIFT DISCHARGE	Feb-93	< 6	
TREATED WATER	Feb-93	< 6	
JOHNSON ST WELL, BARRIE	10-Mar-92	<18	
KENORA WTP	25-Feb-91	< 9	< 9
	26-Aug-91	<10	<10
	22-Jun-92	< 7	< 7
KENORA WTP RAW WATER INFLUENT	Mar-93 June-94	< 6	 < 6
HIGHLIFT DISCHARGE	Mar-93 June-94	< 6	 < 6
KINGSTON WTP	10-Jun-91	11	11
	04-Nov-91	< 9	< 9
	06-Apr-92	13	< 9
	06-Jul-92	< 7	< 7
KINGSTON WTP RAW LAB TAP	 Jan-93 Jan-94 July-94	 7	 8 < 6 < 6
TREATED LAB TAP	Jan-93 Jan-94 July-94	10	 8 < 6
KITCHENER (STRANGE STREET RESERVOIR)	16-Jul-91		<11
KITCHENER WELL SUPPLY	16-Jul-91	<11	<11
KITCHENER (MANNHEIM) WTP RAW WATER	 Mar-93 Apr-94	 < 6	 < 6
FINISHED WATER	Mar-93 Apr-94	< 6	 < 6
MANNHEIM RESERVOIR	Mar-93 Apr-94	< 6	 < 6

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
KITCHENER WELL SUPPLY			
K 2 RAW	Sept-93	< 6	
K 32 RAW	Sept-93	< 6	
K 12 RAW	June-93	< 6	
K 13 RAW	June-93	< 6	
K 17 RAW	June-93	< 6	
STRANGE STREET RESERVOIR	June-93	< 6	
LINDSAY WTP	25-Feb-91	16	14
	09-Sep-91	<10	<10
	28-Oct-91	< 9	9
	25-May-92	15	16
LINDSAY WTP INTAKE SCREEN WELL	July-94		5
HIGHLIFT DISCHARGE	July-94		5
LONDON (LAKE HURON) WSS	18-Nov-91	9	9
	15-Jun-92	10	15
LONDON (LAKE HURON) WSS	Mar-93	< 6	
LOWLIFT DISCHARGE	Mar-94		< 6
SERVICE WATER PUMP	Mar-93	< 6	
	Mar-94		< 6
MADSEN WTP RAW INTAKE	June-94		< 6
DISCHARGE MAIN	June-94		< 6
MANITOUWADGE WELL SUPPLY(WELL1,3,RES)	28-May-91	11	<10
	28-Jan-92	< 8	< 8
MANITOUWADGE WELL SUPPLY			
RAW WELL 1	Oct-93	< 6	
	Aug-94		< 6
RAW WELL 2	Aug-94		< 6
RAW WELL 3	Oct-93	< 6	
	May-94		< 6
RAW WELL 4	May-94		< 6
RAW WELL 5	Aug-94		< 6
RESERVOIR	Oct-93	< 6	
	May-94		< 6
	Aug-94		< 6
MARATHON WELL SUPPLY	22-May-91	<10	<10

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
MARATHON WELL SUPPLY			
RAW WELL 4	May-93	< 6	
RAW WELL 5	May-93	< 6	
RAW WELL 6	May-93	< 6	
RESERVOIR	May-93	< 6	
METRO TORONTO (F.J. HORGAN) WSS	17-Jun-91	<10	<10
	15-Jun-92	12	< 6
RAW DISCHARGE HEADER	Dec-93	9	
	Aug-94		7
RTRD SUCTION CHANNEL	Dec-93	7	
	Aug-94		7
METRO TORONTO (R. L. CLARK) WTP	17-Jun-91	12	17
	19-May-92	17	15
RAW WET WELL	Apr-93	8	
TREATED OUTPUT	Apr-93	< 6	
METRO TORONTO (ISLAND) WTP	19-May-92	14	17
INTAKE VALVE CHAMBER	Apr-94		< 6
DISCHARGE MAIN	Apr-94		7
METRO TORONTO (R.C.HARRIS) WTP			
RAW SUCTION TAP			
	June-93	18	
	June-94		10
OUTPT JOHN ST TUNNEL	June-93	14	
	June-94		12
MILTON WELL SUPPLY	Nov-93	< 6	
RAW WATER	May-94		< 6
MITCHELLS BAY WTP	19-Aug-91	<10	<10
	17-Feb-92	< 9	
	19-Feb-92		< 9
	17-Aug-92	11	8
MITCHELLS BAY WTP	Apr-93	< 6	
LOWLIFT DISCHARGE			
HIGHLIFT DISCHARGE	Apr-93	< 6	
NAPANEE WTP	27-May-91	<11	<11
	22-Jun-92	< 7	12
NAPANEE WTP	May-93	< 6	
RAW WATER TAP	Aug-94		5
TREATED WATER TAP	May-93	< 6	
	Aug-94		6

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
NEWMARKET WELL SUPPLY			
HOLLAND LANDING 1	June-93	< 6	
HOLLAND LANDING 2	Aug-94		< 6
NEWMARKET 1	Aug-94		< 6
NEWMARKET 13	June-93	< 6	
NEWMARKET 14	Aug-94		< 6
NEWMARKET 15	Aug-94		< 6
NEWMARKET 16	Aug-94		< 6
NEWMARKET 2	June-93	< 6	
QUEENSVILLE 3	Aug-94		< 6
QUEENSVILLE 4	June-93	< 6	
NIAGARA FALLS WTP	13-May-91	<10	<10
	09-Sep-91	<10	<10
	11-May-92	< 9	< 9
NIPIGON WTP	27-May-91	<10	<10
	24-Feb-92	< 9	< 9
	27-Jul-92	< 6	7
NIPIGON WTP			
LOWLIFT DISCHARGE	Jan-93	< 6	
	Apr-94		< 6
HIGHLIFT DISCHARGE	Jan-93	< 6	
	Apr-94		< 6
NORTH BAY WTP	18-Jun-91	<10	<10
	28-Oct-91	< 9	< 9
	22-Jun-92	< 7	< 7
NORTH BAY WTP	Mar-93	< 6	
RAW TAP	Mar-94		< 6
TREATED TAP	Mar-94	< 6	
	Mar-94		< 6
NORWICH WELL SUPPLY			
WELL 1	June-93	< 6	
WELL 2	June-93	< 6	
WELL 3	June-93	< 6	
OAKVILLE WTP	13-May-91	<10	<10
	09-Sep-91	<10	<10
	13-Jan-92	< 9	< 9
	13-Oct-92	< 7	< 7
OAKVILLE WTP			
LOWLIFT DISCHARGE	Jan-93	10	
	Apr-94		8

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
HIGHLIFT DISCHARGE	Jan-93	10	
	Apr-94		< 6
ODESSA WTP	22-Apr-91	<11	<11
	26-Aug-91	<10	<10
	28-Oct-91	< 9	< 9
	28-Apr-92	< 8	< 8
ODESSA WTP RAW TAP	Apr-93	< 6	
TREATED TAP	Apr-93	< 6	
ORANGEVILLE WELL SUPPLY	05-Oct-92	< 7	< 7
ORANGEVILLE WELL SUPPLY			
RAW WELL 2	Aug-93	< 6	
	Feb-94		< 6
RAW WELL 3	Aug-93	< 6	
	Feb-94		< 6
RAW WELL 4	May-94		< 6
RAW WELL 5	May-94		< 6
RAW WELL 6	May-94		< 6
RAW WELL 7	Feb-94		< 6
RAW WELL 8A	Feb-94		< 6
RESERVOIR	Aug-93	< 6	
	Feb-94		< 6
OSHAWA WSS	12-Mar-91	28	17
	09-Jul-91	19	14
	14-Jan-92	14	13
	13-Oct-92	9	7
OSHAWA WSS	Jan-93	< 6	
RAW TAP	Apr-94		11
TREATED TAP	Jan-93	9	
	Apr-94		12
OTTAWA (BRITANNIA) WSS	26-Aug-91	13	14
	24-Feb-92	< 9	
OTTAWA (BRITANNIA) WSS RAW WATER TAP	June-94		< 6
TREATED LAB TAP	June-94		< 6
OTTAWA (LEMIEUX ISLAND) WSS	24-Jun-91	37	37
	26-Nov-91	< 8	< 8
	23-Mar-92	< 9	< 9
OTTAWA (LEMIEUX ISLAND) WSS RAW LAB TAP	July-93	7	

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
TREATED LAB TAP	July-93	9	
OTTERVILLE WELL SUPPLY RAW WELL 2	Feb-93	< 6	
RAW WELL 3	Feb-93 Jan-94	< 6	 < 6
RAW WELL 4	Feb-93 Jan-94	< 6	 < 6
OWEN SOUND (RICHARD H. NEATH) WTP	24-Jun-91	<10	<10
	28-Apr-92	< 8	11
RAW WATER INTAKE	July-93 Apr-94	7	 < 6
HIGHLIFT DISCHARGE	July-93 Apr-94	< 6	 11
OWEN SOUND (SPRING SUPPLY) SPRING RAW WATER	July-93 July-94	8	 < 6
PEMBROKE WTP	09-Mar-92	< 9	< 9
	14-Sep-92	13	13
PEMBROKE WTP LOWLIFT DISCHARGE	May-93	7	
HIGHLIFT DISCHARGE	May-93 Sept-94	< 6	 < 6
PERTH WTP	04-May-92	< 8	17
PERTH WTP RAW WELL	Jan-94		6
HIGHLIFT DISCHARGE	Feb-93 Jan-94	< 6	 < 6
PETERBOROUGH WSS	10-Jun-91	<10	<10
	15-Oct-91	9	< 8
	08-Jun-92	7	7
	10-Aug-92	< 6	8
PETERBOROUGH WSS RAW LAB TAP	Apr-93 Aug-94	< 6	 < 6
TREATED LAB TAP	Apr-93 Aug-94	< 6	 < 6
PICTON WTP	13-Jan-92	< 9	< 9
	13-Oct-92	< 7	< 7
PICTON WTP LOWLIFT DISCHARGE	Apr-93	< 6	

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
HIGHLIFT DISCHARGE	Apr-93 Aug-94	< 6	< 6
PLANTAGENET WTP	13-May-91	<10	
	09-Sep-91	<10	<10
	27-Apr-92	< 8	< 8
	08-Jun-92	< 6	< 6
PLANTAGENET WTP RAW WATER TAP	Apr-93	< 6	
TREATED WATER TAP	Apr-93	< 6	
PORT COLBORNE WTP	04-Mar-91	< 8	10
	05-Aug-91	<10	
	06-Aug-91		<10
	13-Jul-92	< 7	< 7
PORT COLBORNE WTP LOWLIFT DISCHARGE	Jan-93 Jan-94	< 6	< 6
DISTRIBUTION HEADER	Jan-93 Jan-94	< 6	< 6
PORT DOVER (DOANS HOLLOW) SPRING SUPPLY	22-Jul-91	<11	12
PORT DOVER (SPRING SUPPLY) DOANS HOLLOW RAW	Feb-93	< 6	
DOANS HOLLOW TREATED	Feb-93	< 6	
PORT DOVER WSS	22-Jul-91	13	11
PORT DOVER RAW TAP	Feb-93 Feb-94	< 6	8
TREATED TAP	Feb-93 Feb-94	< 6	9
PORT ELGIN WTP	04-May-92	16	17
	05-Aug-92	14	16
PORT ELGIN WTP LOWLIFT DISCHARGE	Feb-93 Mar-94	24	19
HIGHLIFT DISCHARGE	Feb-93	24	
PORT HOPE WTP	04-Mar-91	< 8	13
	28-Oct-91	< 9	< 9
	23-Mar-92	10	12
PORT HOPE WTP RAW TAP	Apr-93 Apr-94	10	12

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
TREATED TAP	Apr-93	9	
	Apr-94		11
PORT ROWAN WTP	May-93	< 6	
RAW WATER	Mar-94		8
TREATED WATER	May-93	< 6	
	Mar-94		< 6
PORT STANLEY WTP	24-Jun-91	<10	<10
	23-Mar-92	< 9	< 9
PORT STANLEY WTP	Aug-93	< 6	
LOWLIFT CHAMBER	Sept-93	< 6	
	Mar-94		< 6
FILTER DISCHARGE	Aug-93	< 6	
	Sept-93	< 6	
	Mar-94		< 6
PRESCOTT WTP	19-Aug-91	<10	<10
	16-Mar-92	< 9	
PRESCOTT WTP	Mar-94		8
LOWLIFT DISCHARGE			
TREATED WATER	Mar-94		11
RAINY RIVER WTP	10-Jun-91	<10	
	11-Jun-91		<10
	13-Nov-91	< 8	< 8
	13-Apr-92	< 8	
	14-Apr-92		< 8
RAINY RIVER WTP	May-93	< 6	
RAW WATER INTAKE	Sept-93	< 6	
	July-94		< 6
DISTRIBUTION MAIN	May-93	< 6	
	Sept-93	< 6	
	July-94		< 6
RED LAKE WTP	June-94		< 6
RAW WET WELL			
HIGHLIFT DISCHARGE	June-94		< 6
RED ROCK	18-Jun-91	<10	<10
	24-Mar-92	< 9	< 9
RED ROCK WTP	May-93	< 6	
LOWLIFT DISCHARGE	May-94		< 6
HIGHLIFT DISCHARGE	May-93	< 6	
	May-94		< 6

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
RENFREW WTP	08-Apr-91	<11	11
	15-Oct-91	< 8	< 8
	13-Apr-92	9	< 8
RENFREW WTP RAW VALVE CHAMBER	Apr-93 Aug-94	< 6	< 6
HIGHLIFT DISCHARGE	Apr-93 Aug-94	< 6	< 6
ROCKLAND WTP	11-Feb-91	18	<18
	12-Aug-91	16	15
	13-Jan-92	< 9	10
ROCKLAND WTP RAW WATER TAP	Sept-93 Sept-94	< 6	< 6
TREATED WATER TAP	Sept-93 Sept-94	< 6	< 6
SARNIA (LAMBTON COUNTY) WTP	03-Jul-91		<10
	04-Nov-91	< 9	
	05-Nov-91		< 9
	03-Feb-92	< 9	
	04-Feb-92		< 9
	04-Aug-92	8	10
SARNIA (LAMBTON COUNTY) WTP RAW TAP	Apr-93 Aug-94	< 6	5
HIGHLIFT DISCHARGE	Apr-93 Aug-94	< 6	< 6
SAULT STE MARIE (GOULAIS WELL)	10-Feb-92	< 9	< 9
SAULT STE MARIE (LORNA WELL)	08-Jul-91	<11	<11
	11-May-92	< 9	< 9
SAULT STE MARIE (SHANNON WELL)	11-May-92	< 9	< 9
SAULT STE MARIE (STEELTON WELL)	08-Jul-91	<11	<11
SAULT STE MARIE WTP	08-Jul-91	<11	<11
SAULT STE MARIE WTP PLANT RAW TAP	Nov-93	< 6	
PLANT TREATED TAP	Nov-93	< 6	
SAULT WELL SUPPLY RAW TAP	Aug-93 Nov-93 May-94	< 6 < 6	< 6
TREATED TAP	Aug-93	< 6	

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
SIMCOE WELL SUPPLY			
NORTHWEST ONE RAW	Sept-93	< 6	
NORTHWEST TWO RAW	Sept-93	< 6	
SIMCOE WELL 1	Sept-94		< 6
SIMCOE WELL 4	Sept-93	< 6	
	Sept-94		< 6
TREATED RESERVOIR	Sept-93	< 6	< 6
	Sept-94		
SMITH FALLS WTP	15-Oct-91	< 8	< 8
	13-Jan-92	< 9	< 9
	14-Sep-92	< 6	< 6
SMITH FALLS WTP	Jan-93	< 6	
RAW WATER	Jan-94		< 6
TREATED WATER	Jan-93	< 6	
	Jan-94		< 6
SOUTH PEEL (LAKEVIEW) WSS	02-Jul-91	<10	<10
SOUTH PEEL (LAKEVIEW) WSS	Mar-93	9	
INTAKE LINE			
TREATED LAB TAP	Mar-93	12	
SOUTH PEEL (LORNE PARK) WSS	12-Aug-91	<11	
SOUTH PEEL (LORNE PARK) WSS	Jan-93	11	
INTAKE LINE	Jan-94		7
TREATED LAB TAP	Jan-93	10	
	Jan-94		8
SOUTHAMPTON WTP	July-93	15	
LOWLIFT DISCHARGE			
HIGHLIFT DISCHARGE	July-93	16	
ST CATHARINES (DE CEW) WSS	18-Mar-91	9	< 9
	16-Sep-91	<10	<10
	20-Jan-92	< 9	< 9
ST CATHARINES (DE CEW) WSS	Apr-93	< 6	
RAW TAP	Apr-94		< 6
TREATED TAP	Apr-93	< 6	
	Apr-94		< 6
ST THOMAS (ELGIN) WSS	02-Jul-91	<10	<10
	04-Nov-91	< 9	< 9
	06-Jan-92	< 8	9
	06-Jul-92	< 7	< 7

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
ST THOMAS (ELGIN) WSS RAW TAP	Jan-93 Jan-94 July-94	< 6 < 6	 < 6
TREATED TAP	Jan-93 Jan-94 July-94	< 6 < 6	 6
STONEY POINT (TILBURY NORTH) WSS	22-Jul-91	11	11
	27-Apr-92	< 8	< 8
STONEY POINT (TILBURY NORTH) WSS LOWLIFT DISCHARGE	Jan-93	< 6	
TREATED LAB TAP	Jan-93	< 6	
STOUFFVILLE WELL SUPPLY	20-Aug-91	<10	<10
STOUFFVILLE WELL SUPPLY RAW WELL 5	Mar-93 Sept-94	< 6 	 < 6
RAW WELL 6	Mar-93 Sept-94	< 6 	 < 6
TREATED TAP	Mar-93 Sept-94	< 6 	 < 6
STRATFORD WELL SUPPLY	13-Jul-92	<42	< 7
STRATFORD WELL SUPPLY FIELD WELL 1 FIELD WELL 2 FIELD WELL 3 FIELD WELL 4 FIELD WELL 6 FIELD WELL 7	 July-93 Aug-94 July-93 July-93 July-93 Aug-94 July-93 Aug-94 July-93 Aug-94	 < 6 < 6 < 6 < 6 < 6 < 6 	 < 6 < 6 < 6 < 6
LORNE AVENUE	July-93	< 6	
RESERVOIR	July-93	< 6	
SUDBURY (DAVID ST) WTP	05-Jun-91	<11	<11
	06-Jan-92	< 8	< 8
	08-Jul-92	< 7	< 7
SUDBURY (DAVID ST) WTP RAW TAP	May-93	< 6	
TREATED TAP	May-93	< 6	
SUDBURY (WANAPITEI) WSS	04-Jun-91	<11	
	05-Jun-91		<11
	06-Jan-92	< 8	< 8

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
	08-Jul-92	< 6	< 6
SUDBURY (WANAPITEI) WSS RAW TAP	May-93	< 6	
TREATED TAP	May-93	< 6	
TECUMSEH WTP	19-Aug-91	<10	<10
	20-Jul-92	7	< 6
TECUMSEH WTP LOWLIFT DISCHARGE	Jan-93 Jan-94	38	 < 6
TREATED SERVICE LINE	Jan-93 Jan-94	31	 < 6
TERRACE BAY	21-May-91	<10	<10
	23-Apr-92	< 8	< 8
TERRACE BAY WTP LOWLIFT WELL	Sept-93	< 6	
HIGHLIFT DISCHARGE	Sept-93	< 6	
THAMESVILLE WELL SUPPLY	16-Apr-91	<11	<11
	21-Oct-91	< 9	< 9
	20-Jul-92	< 6	< 6
THAMESVILLE WELL SUPPLY RAW WATER TAP	Jan-93 July-94	< 6	 < 6
TREATED WATER TAP	Jan-93 July-94	9	 < 6
THUNDER BAY (BARE POINT) WTP	08-Apr-91	<11	<22
	15-Oct-91	< 8	< 8
THUNDER BAY (BARE POINT) WTP RAW TAP	Aug-93	< 6	
TREATED TAP	Aug-93	< 6	
THUNDER BAY (LOCH LOMOND) WTP	08-Apr-91	<11	<11
TILBURY WTP	15-Jul-91	<11	<11
	17-Feb-92	< 9	< 9
	17-Aug-92	11	8
TILBURY WTP LOWLIFT DISCHARGE	Aug-93 Feb-94	< 6	 < 6
PLANT EFFLUENT	Aug-93 Feb-94	6	 < 6

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
TILLSONBURG WELL SUPPLY			
RAW WELL 10	June-94		< 6
RAW WELL 1A	June-94		< 6
RAW WELL 5	June-94		< 6
RAW WELL 6	June-94		< 6
TREATED WELL 2	June-94		< 6
TRENTON (CHESTER ROAD) WTP	03-Jun-91	<11	<11
TRENTON WTP LOWLIFT DISCHARGE	May-94		< 6
HIGHLIFT DISCHARGE	May-94		< 6
TRENTON SPRING SUPPLY	03-Jun-91	<11	<11
UNION WSS	06-Aug-91	<10	<10
	07-Oct-91	10	
	08-Oct-91		10
UNION (ESSEX COUNT) WSS RAW TAP	Mar-93 Mar-94	< 6	 11
TREATED TAP	Mar-93 Mar-94	< 6	 10
WALLACEBURG WTP	13-May-91	<10	
	14-May-91		<10
	09-Sep-91	<10	<10
	08-Jun-92	7	8
	17-Aug-92	11	8
WALLACEBURG WTP LOWLIFT DISCHARGE	Oct-93 Oct-94	14	 < 6
HIGHLIFT DISCHARGE	Oct-93 Oct-94	12	 < 6
WALPOLE ISLAND WTP	02-Jul-91	<11	15
	03-Sep-91	<10	<10
	07-Jul-92	8	
	08-Jul-92		< 7
WALPOLE ISLAND WTP RAW WATER INTAKE	July-93 Sept-94	< 6	 5
TREATED LAB TAP	July-93 Sept-94	7	 4
WATERLOO WELL SUPPLY (W7,ERB ST RES)	16-Jul-91		<11
	22-Jul-92	< 6	< 6

WATER SUPPLY	DATE	RAW WATER	TREATED WATER
WATERLOO WELL SUPPLY(W2,WILLIAM ST RES)	16-Jul-91	<11	<11
	21-Jul-92	< 6	10
WATERLOO WELL SUPPLY 1C RAW WELL	Oct-94		< 6
W2 RAW WELL	Aug-93	< 6	
W3 RAW WELL	Aug-93	< 6	
	Oct-94		< 6
WILLIAM ST RESERVOIR	Aug-93	< 6	
	Oct-94		< 6
WELLAND WSS	02-Sep-91	<10	<10
	03-Feb-92	< 9	< 9
	04-Aug-92	6	< 6
WELLAND WSS LOWLIFT DISCHARGE	Nov-93	< 6	
	May-94		< 6
DISTRIBUTION MAIN	Nov-93	< 6	
	May-94		< 6
WHITBY WTP RAW WATER	June-94		< 6
HIGHLIFT DISCHARGE	June-94		< 6
WINDSOR WSS	17-Jun-91	<10	
	18-Jun-91		<10
	12-Nov-91	<10	
	13-Nov-91		< 8
	08-Jun-92	8	9
	10-Aug-92	7	
	11-Aug-92		9
WINDSOR WSS LOWLIFT CHAMBER	Apr-93	< 6	
	Feb-94		< 6
HIGHLIFT DISCHARGE	Apr-93	< 6	
	Feb-94		< 6

Note: (a) < denotes *less than*

APPENDIX E.2

TRITIUM DATA

NUCLEAR SURVEILLANCE PROGRAM

APPENDIX E2

TABLE 1: ROUTINE DRINKING WATER SAMPLING LOCATIONS FOR TRITIUM UNDER THE MOEE NUCLEAR SURVEILLANCE PROGRAM

Water Treatment Plant	Nearest Nuclear Facility	Source of Water Supply	Sampling Routine
Kincardine	Ontario Hydro - Bruce	Lake Huron	monthly composite* - treated water as of July/94 - weekly composite
Port Elgin	Ontario Hydro - Bruce	Lake Huron	monthly composite - treated water as of July/94 - weekly composite
Bowmanville	Ontario Hydro - Darlington	Lake Ontario	weekly composite - treated water
Newcastle	Ontario Hydro - Darlington	Lake Ontario	weekly composite - treated water
Ajax W.A. Parish	Ontario Hydro - Pickering	Lake Ontario	weekly composite - treated water
Whitby	Ontario Hydro - Pickering	Lake Ontario	weekly composite - treated water
Oshawa	Ontario Hydro - Pickering	Lake Ontario	weekly composite - treated water
R.C. Harris	Ontario Hydro - Pickering	Lake Ontario	weekly composite - treated water
R.L. Clark	Ontario Hydro - Pickering	Lake Ontario	weekly composite - treated water
Horgan (Scarborough)	Ontario Hydro - Pickering	Lake Ontario	weekly composite - treated water
Lakeview	Ontario Hydro - Pickering	Lake Ontario	weekly composite - raw water as of June/94 - monthly composite
Lorne Park	Ontario Hydro - Pickering	Lake Ontario	weekly composite - raw water as of June/94 - monthly composite
Petawawa	Atomic Energy Canada Ltd.	Ottawa River	monthly composite - treated water
Deep River	Atomic Energy Canada Ltd.	Ottawa River	monthly composite - treated water
Pembroke	Atomic Energy Canada Ltd.	Ottawa River	monthly composite - treated water
Rolphton	Atomic Energy Canada Ltd.	Ottawa River	monthly composite - treated water
Amherstburg	Enrico Fermi, Michigan Davis Besse, Ohio	Lake Michigan	monthly composite - treated water
Harrow-Colchester	Enrico Fermi, Michigan Davis Besse, Ohio	Lake Michigan	monthly composite - treated water
Wheatley	Enrico Fermi, Michigan Davis Besse, Ohio	Lake Michigan	monthly composite - treated water

* A composite sample is composed of equal quantities of water collected each day over a sampling period (i.e. 1 week or 1 month)

APPENDIX E2 **TABLE 2: Weekly Averages of Tritium Concentrations at Water Treatment Plants Near Nuclear Facilities For the Period Between December 1988 - November 1994**

Water Treatment Plant	Period[2]	Tritium Concentration[1] (Bq/L)		
		Weekly Average	Maximum	Standard Deviation
Kincardine	Dec. 1988 - Oct. 1994	8.15*	29	5.37
Port Elgin	Feb. 1991 - Sept. 1994	41.39*	300	49.94
Ajax W.A. Parish	Nov. 1988 - Nov. 1994	19.46	220	20.00
Bowmanville	Jul. 1989 - Nov. 1994	10.13	30	4.49
Newcastle	Jul. 1989 - Nov. 1994	10.12	77	5.95
Oshawa	Dec. 1988 - Nov. 1994	13.02	75	8.60
Whitby	Jul. 1989 - Nov. 1994	12.05	210	14.88
R.C. Harris	Dec. 1988 - Nov. 1994	9.85	180	11.09
R.L. Clark	Dec. 1988 - Nov. 1994	9.33	73	6.62
Horgan	Dec. 1988 - Nov. 1994	9.59	150	9.07
Amherstburg	Dec. 1989 - Oct. 1994	6.08*	34	4.18
Harrow-Colchester	Dec. 1989 - Oct. 1994	5.66*	12	1.98
Wheatley	Dec. 1989 - Oct. 1994	5.45*	12	2.03
Petawawa	Dec. 1989 - Oct. 1994	9.98*	33	6.29
Deep River	Dec. 1989 - Oct. 1994	6.56*	41	6.23
Pembroke	Dec. 1989 - Oct. 1994	10.70*	120	15.47
Rolphton	Dec. 1989 - Oct. 1994	6.31*	64	7.97
Lakeview	Oct. 1992 - Nov. 1994	8.52	15	2.87
Lorne Park	Oct. 1992 - Nov. 1994	8.43	14	2.88

[1] Sample values less than detection limit were multiplied by 0.6 before treatment in the average, maximum or standard deviation calculations. Detection limit range: 6 - 9 Bq/L

[2] Period in which tritium monitoring data was readily available.

* Denote monthly averages

Data Source: Ministry of Labour, Radiation Protection Service Laboratory

APPENDIX E2 TABLE 3: Yearly Averages of Tritium Concentrations[1] At Water Treatment Plants Near Nuclear Facilities (1989 - 1991)

Water Treatment Plant	1989			1990			1991		
	Average	Max.	Std. Dev	Average	Max.	Std. Dev	Average	Max.	Std. Dev
Kincardine	9.83	29	7.03	6.29	11	2.07	11.21	25	4.91
Port Elgin	N/A			N/A			80.73	300	80.94
Ajax W.A. Parish	19.23	79	17.68	19.96	100	17.02	19.61	57	12.65
Bowmanville	8.96*	21	3.95	10.73	30	5.28	11.45	27	4.79
Newcastle	7.95*	15	3.14	10.61	24	4.50	11.18	24	5.21
Oshawa	13.50	52	10.12	11.85	26	6.23	14.58	36	7.42
Whitby	8.77*	28	4.96	11.17	36	7.07	12.83	36	6.52
R.C. Harris	8.78	21	4.36	7.88	23	3.68	9.87	20	3.94
R.L. Clark	8.19	17	3.55	7.44	22	3.54	10.45	57	7.27
Horgan	8.39	19	3.82	8.04	32	4.46	10.51	20	4.42
Amherstburg	N/A			5.25	8	0.90	8.75	34	7.88
Harrow-Colchester	N/A			5.25	8	0.90	6.87	12	2.14
Wheatley	N/A			5.50	12	2.01	6.12	11	1.54
Petawawa	N/A			14.11	33	8.70	11.22	25	6.45
Deep River	N/A			8.54	35	8.29	6.62	12	2.06
Pembroke	N/A			11.80	23	6.34	19.87	120	30.67
Rolphton	N/A			5.67	10	1.48	6.62	13	2.08
Lakeview	N/A			N/A			N/A		
Lorne Park	N/A			N/A			N/A		

[1] Sample values less than detection limit were multiplied by 0.6 before treatment in the average, maximum or standard deviation calculations. Detection limit range: 6 - 9 Bq/L

* Based on 6 months of data

N/A = not available

Data Source: Ministry of Labour, Radiation Protection Service Laboratory

APPENDIX E2 TABLE 4: Yearly Averages of Tritium Concentrations[1] at Water Treatment Plants Near Nuclear Facilities (1992 - 1994)

Water Treatment Plant	1992			1993			1994*		
	Average	Max.	Std. Dev	Average	Max.	Std. Dev	Average	Max.	Std. Dev
Kincardine	8.33	25	5.90	10.54	25	5.86	4.93	14	2.40
Port Elgin	43.50	200	50.03	37.20	93	26.45	21.00	36	7.35
Ajax W.A. Parish	26.14	220	34.82	17.73	95	15.91	12.09	29	7.42
Bowmanville	10.87	28	4.57	10.07	18	3.26	7.80	18	3.36
Newcastle	10.41	22	3.83	9.59	22	3.34	9.70	77	10.82
Oshawa	15.09	75	11.20	12.61	45	8.10	9.31	19	4.39
Whitby	17.81	210	32.03	11.11	28	4.87	8.69	18	4.04
R.C. Harris	13.24	180	23.65	11.05	68	8.77	7.77	14	3.28
R.L. Clark	12.81	73	11.80	9.56	17	2.83	7.16	13	3.05
Horgan	12.53	150	19.58	10.25	21	3.54	7.58	17	3.45
Amherstburg	6.08	10	2.31	5.21	11	2.26	5.15	10	1.92
Harrow-Colchester	5.32	9	1.84	4.96	10	2.05	5.89	9	2.17
Wheatley	5.41	11	2.41	5.17	10	2.10	5.10	9	1.80
Petawawa	8.95	15	4.34	8.83	15	3.56	4.20	6	0.93
Deep River	8.04	41	10.08	4.79	8	1.48	4.60	8	1.34
Pembroke	8.62	15	3.97	7.21	15	4.03	5.45	12	2.53
Rolphton	9.79	64	16.40	4.61	8	1.58	4.20	7	1.03
Lakeview	N/A			9.34	15	2.52	7.96	14	3.00
Lorne Park	N/A			9.32	14	2.60	6.96	11	2.86

* Based on 10-11 months of data

N/A = not available

[1] Sample values less than detection limit were multiplied by 0.6 before treatment in the average, maximum or standard deviation calculations. Detection limit range: 6 - 9 Bq/L

Data Source: Ministry of Labour, Radiation Protection Service Laboratory

APPENDIX E2 TABLE 5: Summary of Annual Averages of Tritium Concentrations[1] at Water Treatment Plants Near Nuclear Facilities (1989 - 1994)

Water Treatment Plant	Year Averages					
	1989	1990	1991	1992	1993	1994*
Kincardine	9.83	6.29	11.21	8.33	10.54	4.93
Port Elgin			80.73	43.50	37.20	21.00
Ajax W.A. Parish	19.23	19.96	19.61	26.14	17.73	12.09
Bowmanville	8.96	10.73	11.45	10.87	10.07	7.80
Newcastle	7.95	10.61	11.18	10.41	9.59	9.70
Oshawa	13.50	11.85	14.58	15.09	12.61	9.31
Whitby	8.77	11.17	12.83	17.81	11.11	8.69
R.C. Harris	8.78	7.88	9.87	13.24	11.05	7.77
R.L. Clark	8.19	7.44	10.45	12.81	9.56	7.16
Horgan	8.39	8.04	10.51	12.53	10.25	7.58
Amherstburg		5.25	8.75	6.08	5.21	5.15
Harrow-Colchester		5.25	6.87	5.32	4.96	5.89
Wheatley		5.50	6.12	5.41	5.17	5.10
Petawawa		14.11	11.22	8.95	8.83	4.20
Deep River		8.54	6.62	8.04	4.79	4.60
Pembroke		11.80	19.87	8.62	7.21	5.45
Rolphton		5.67	6.62	9.79	4.61	4.20
Lakeview					9.34	7.96
Lorne Park					9.32	6.96

* based on 9-11 months data

[1] Sample values less than detection limit were multiplied by 0.6 before calculation of the annual average.
Detection limit range: 6 - 9 Bq/L

Data Source: Ministry of Labour, Radiation Protection Service Laboratory

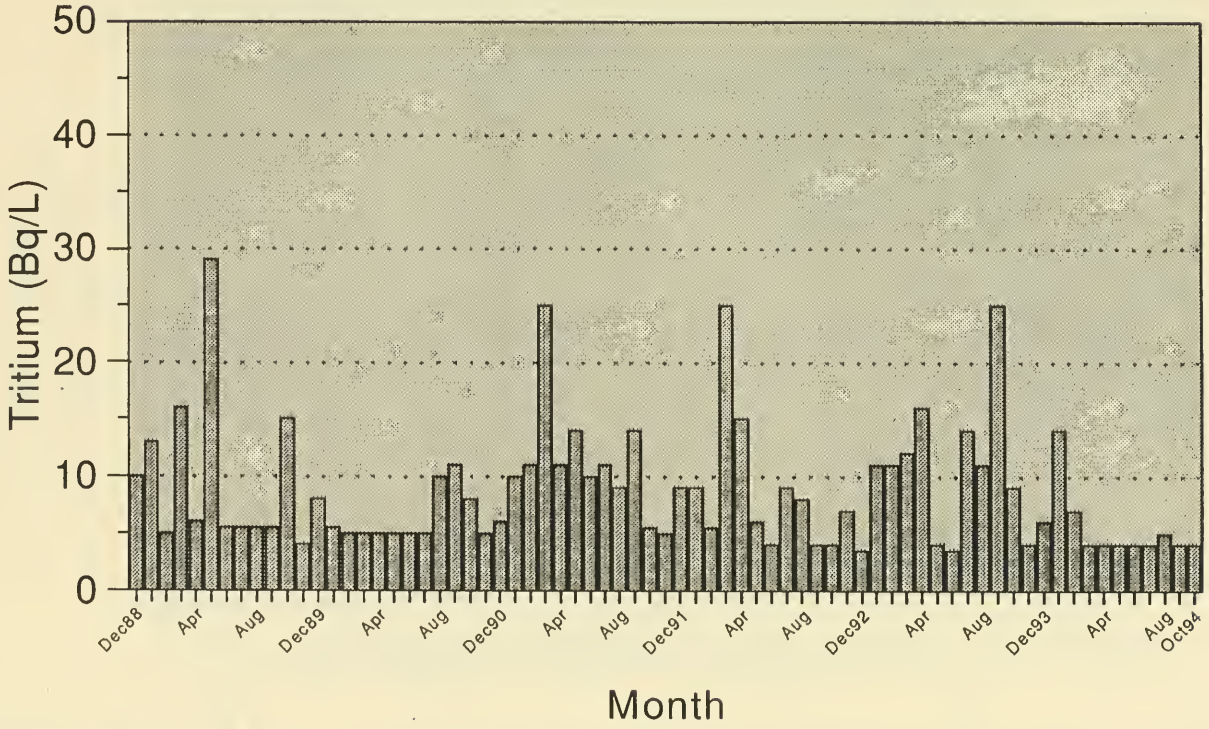
APPENDIX E.3

TRITIUM DATA

TIME SERIES GRAPHS

Kincardine Water Treatment Plant

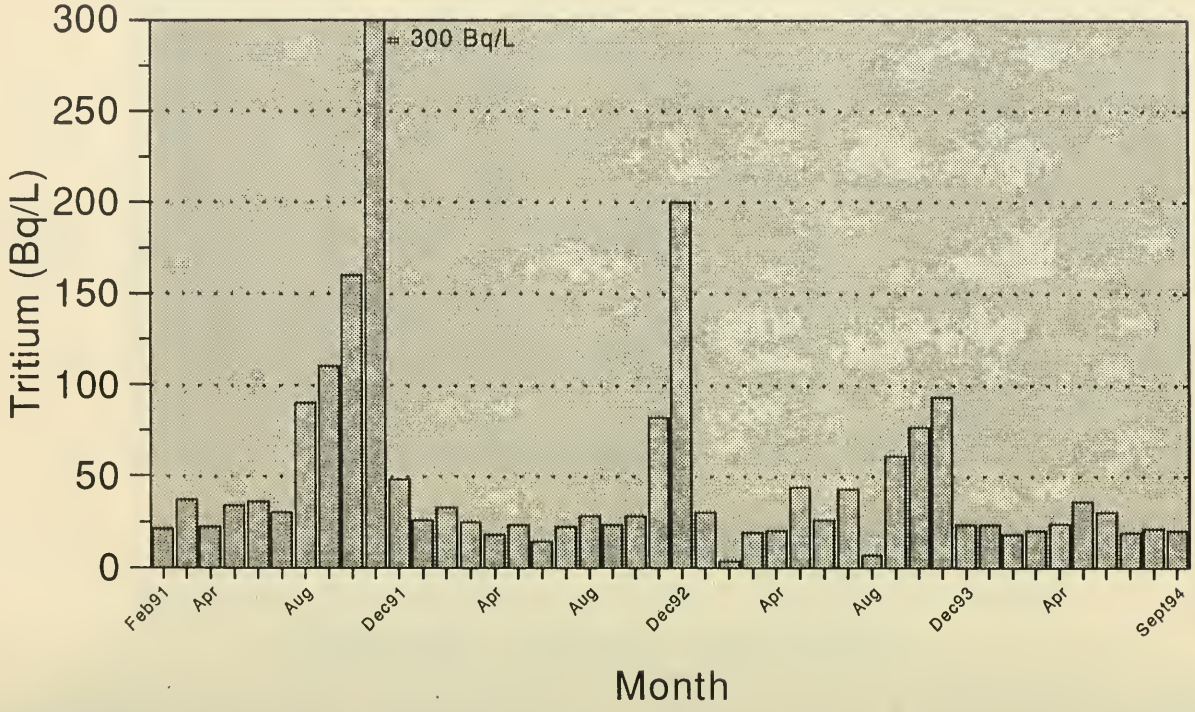
Monthly Tritium Averages
Period: December 1988 - October 1994



Source: Ontario Ministry of Labour

Port Elgin Water Treatment Plant

Monthly Tritium Averages
Period: February 1991 - September 1994

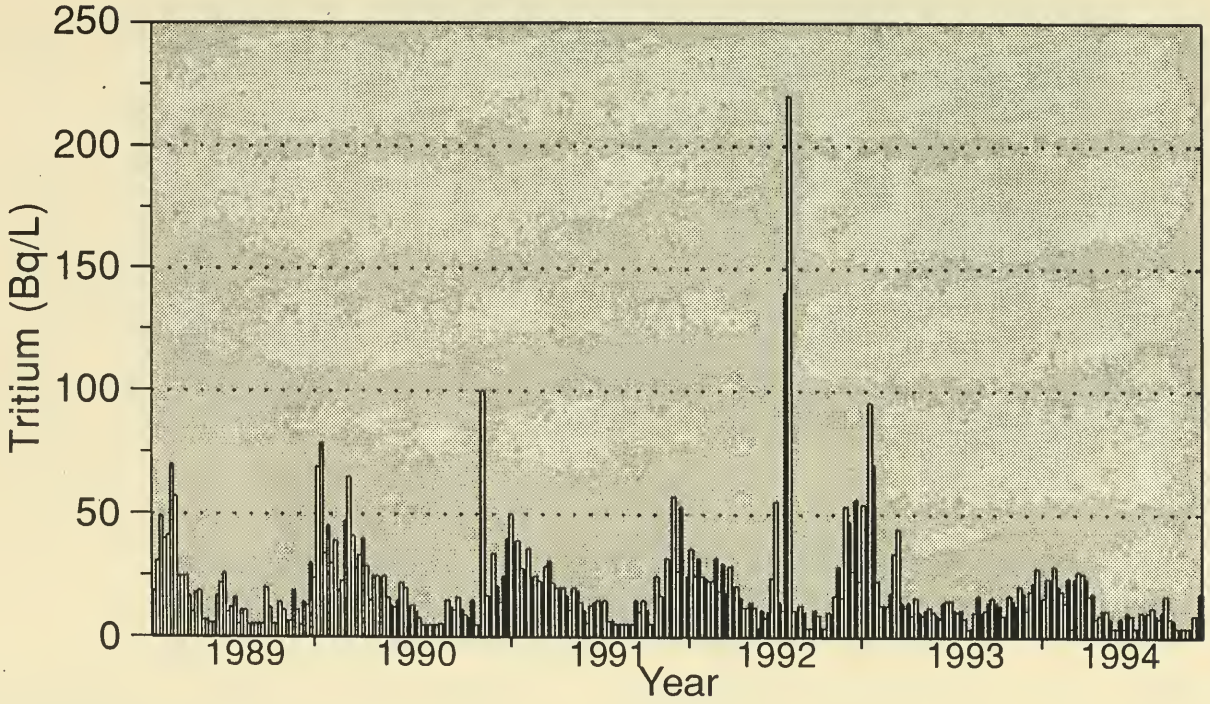


Source: Ontario Ministry of Labour

Ajax Water Treatment Plant

Weekly Tritium Averages

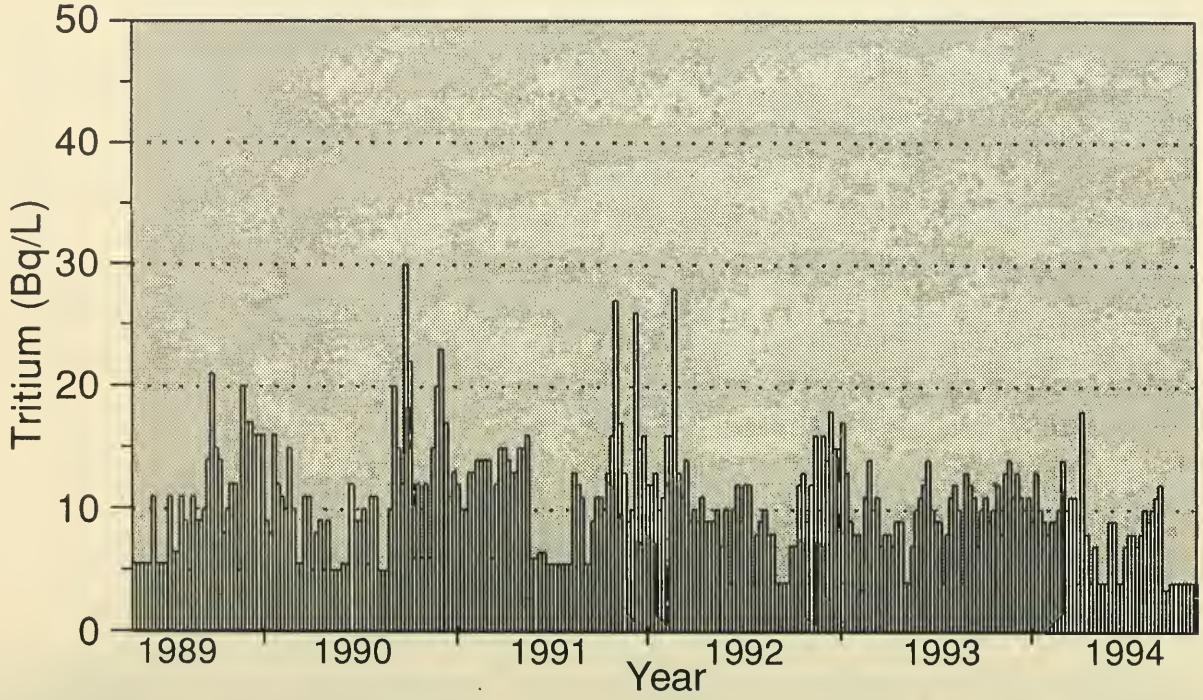
Period: November 1988 - November 1994



Source: Ontario Ministry of Labour

Bowmanville Treatment Plant

Weekly Tritium Averages
Period: July 1989 - November 1994

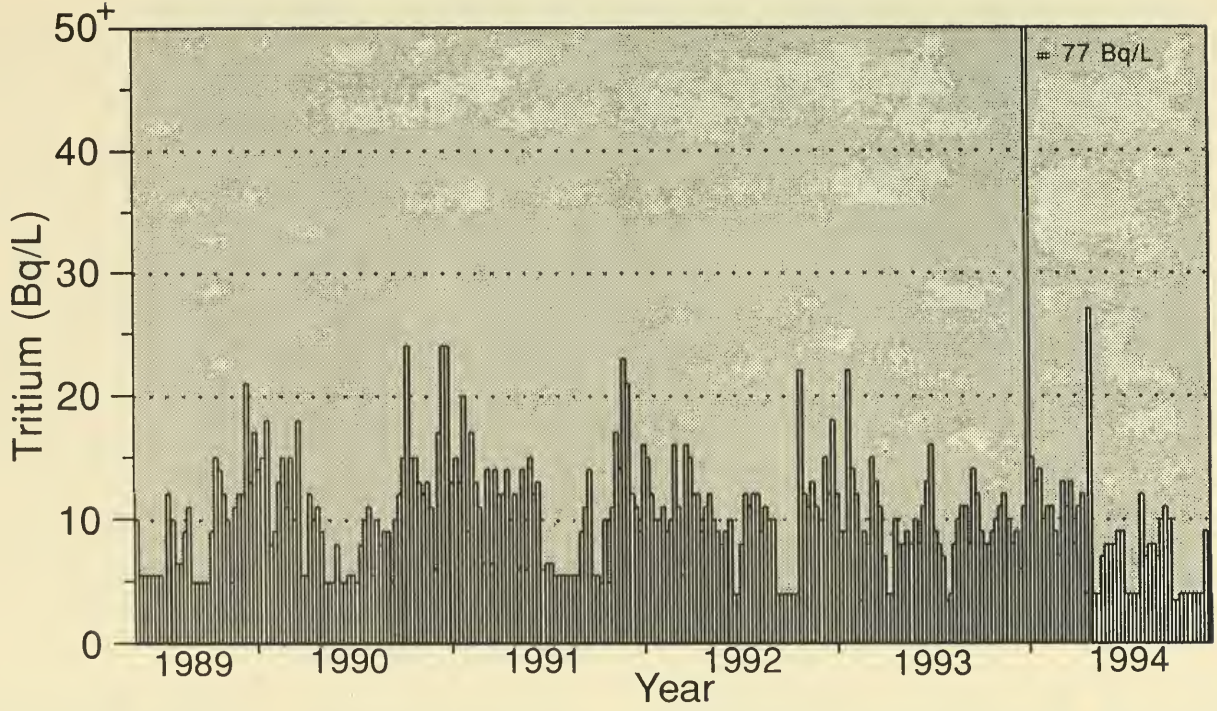


Source: Ontario Ministry of Labour

Newcastle Treatment Plant

Weekly Tritium Averages

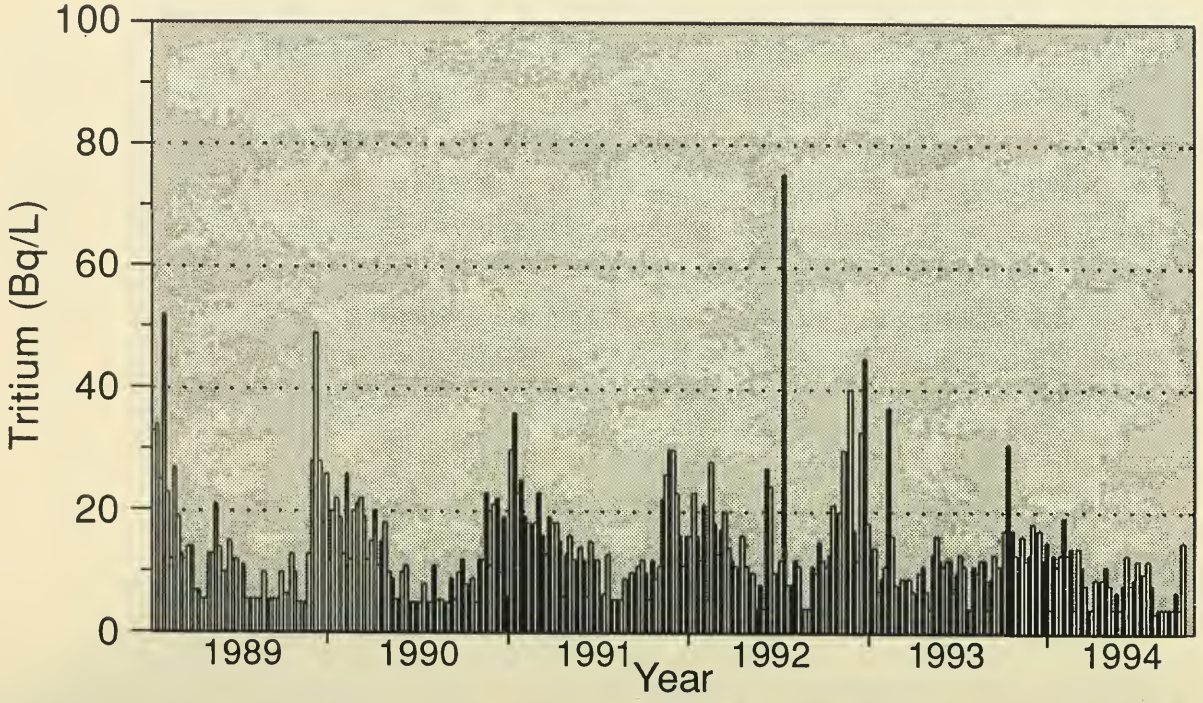
Period: July 1989 - November 1994



Source: Ontario Ministry of Labour

Oshawa Water Treatment Plant

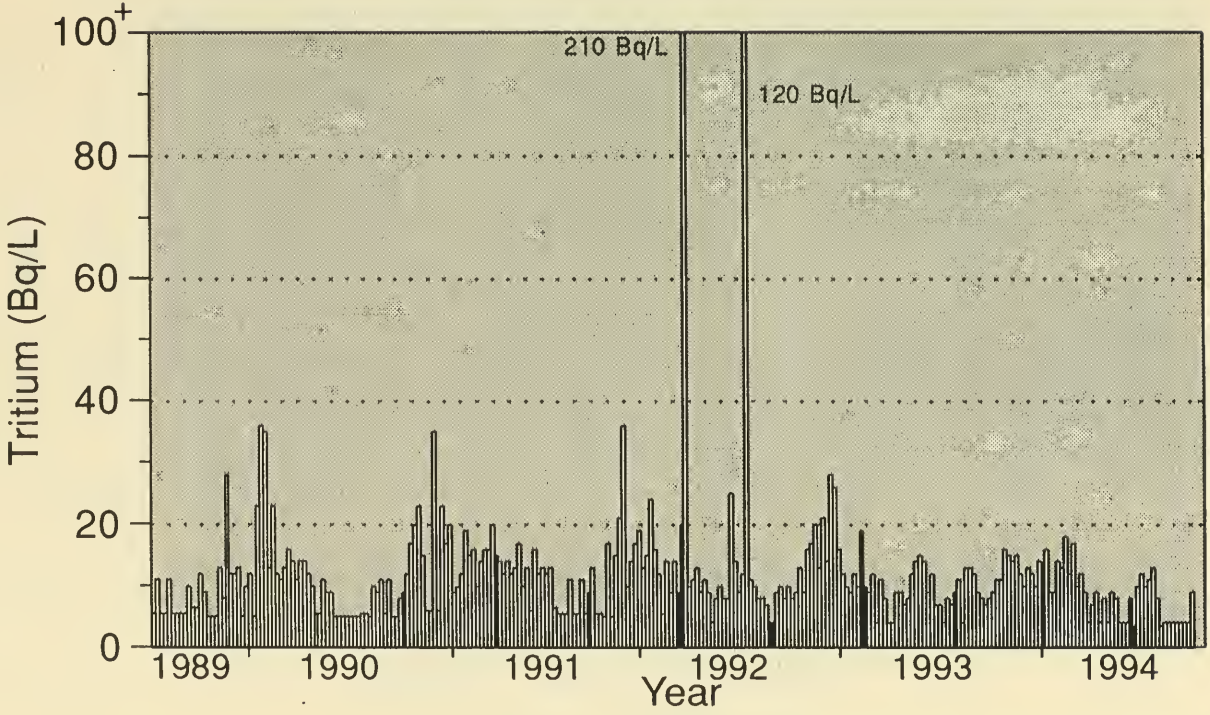
Weekly Tritium Averages
Period: December 1988 - November 1994



Source: Ontario Ministry of Labour

Whitby Treatment Plant

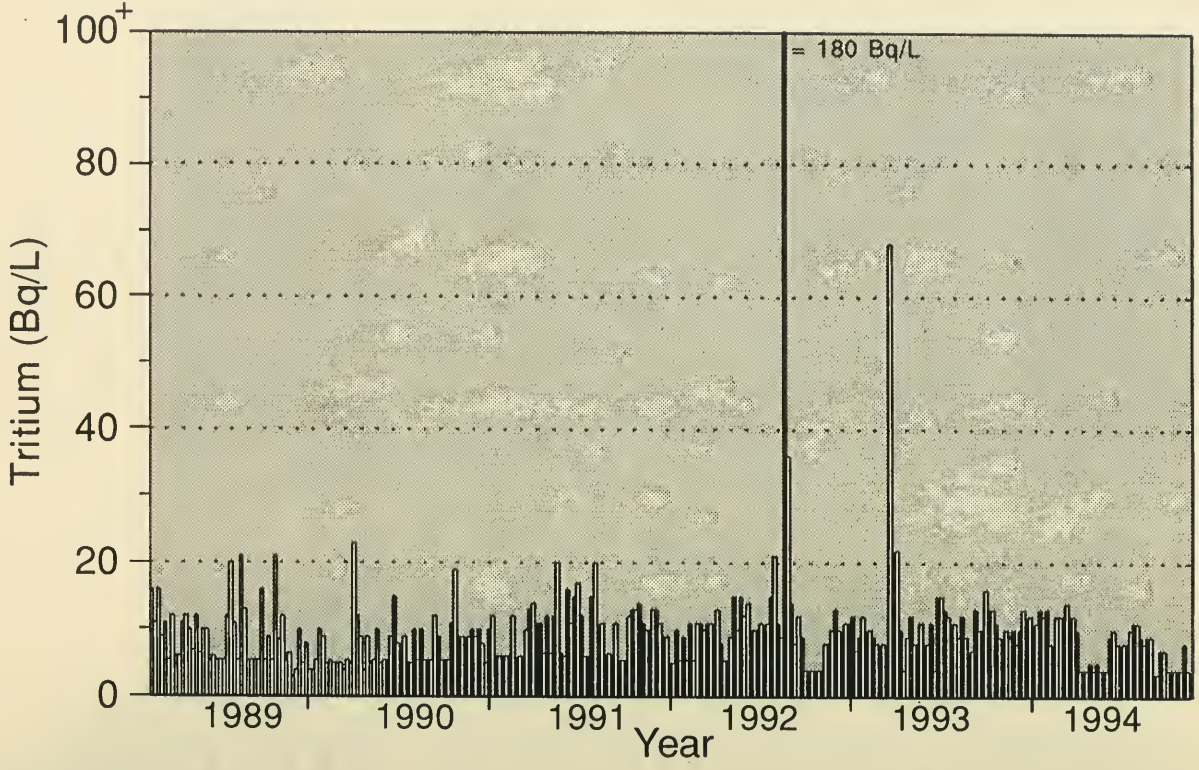
Weekly Tritium Averages
Period: July 1989 - November 1994



Source: Ontario Ministry of Labour

R.C. Harris

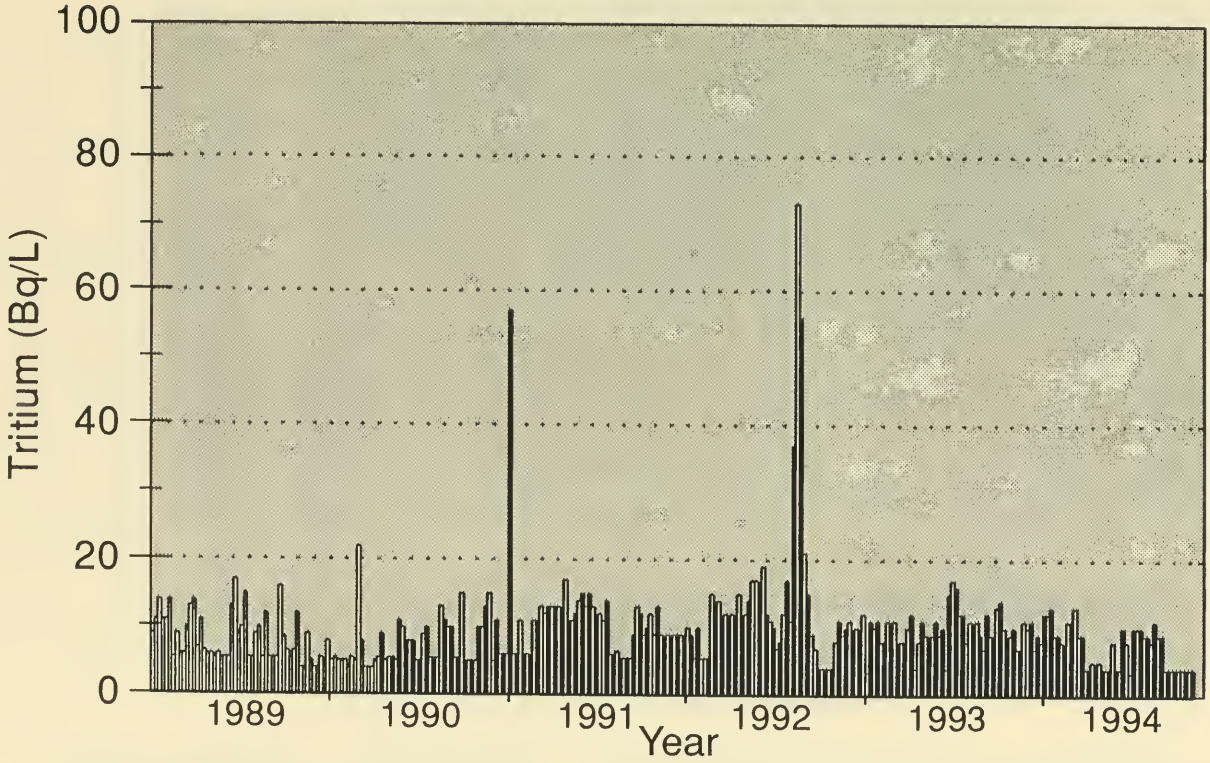
Weekly Tritium Averages
Period December 1988 - November 1994



Data Source: Ontario Ministry of Labour

R.L. Clark Water Treatment Plant

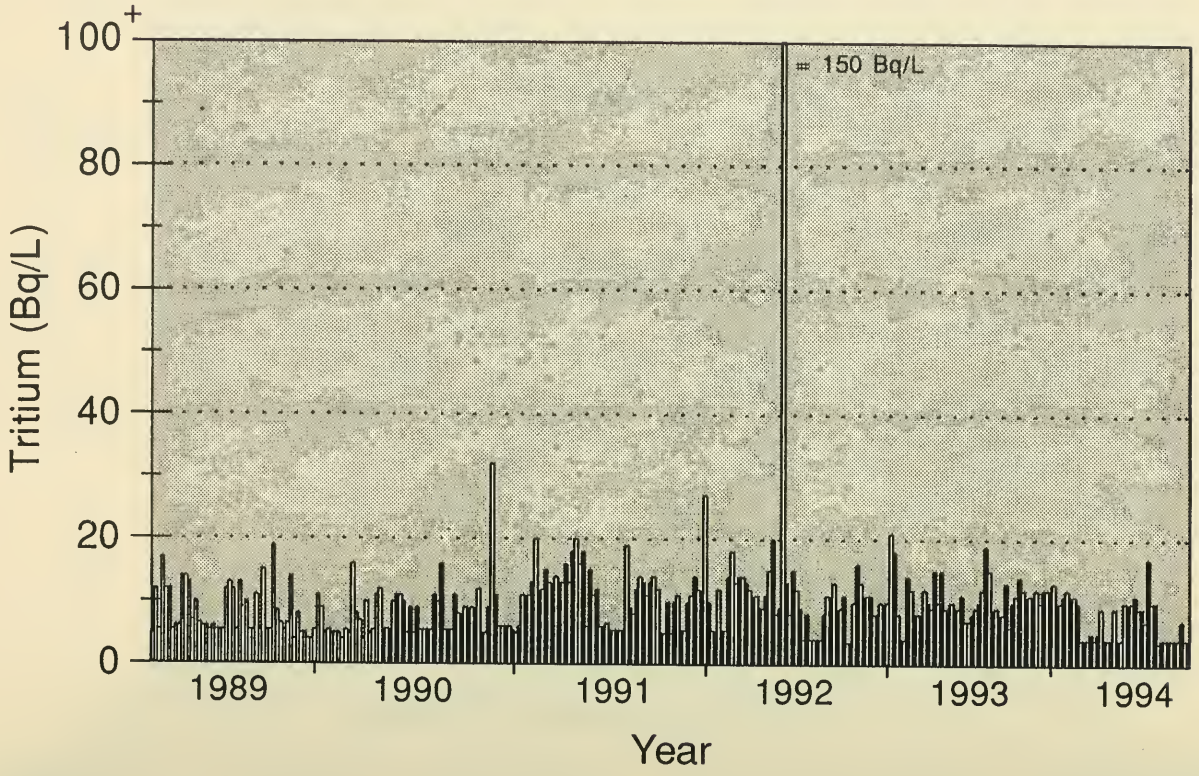
Weekly Tritium Averages
Period December 1988 - November 1994



Data Source: Ontario Ministry of Labour

Horgan Water Treatment Plant

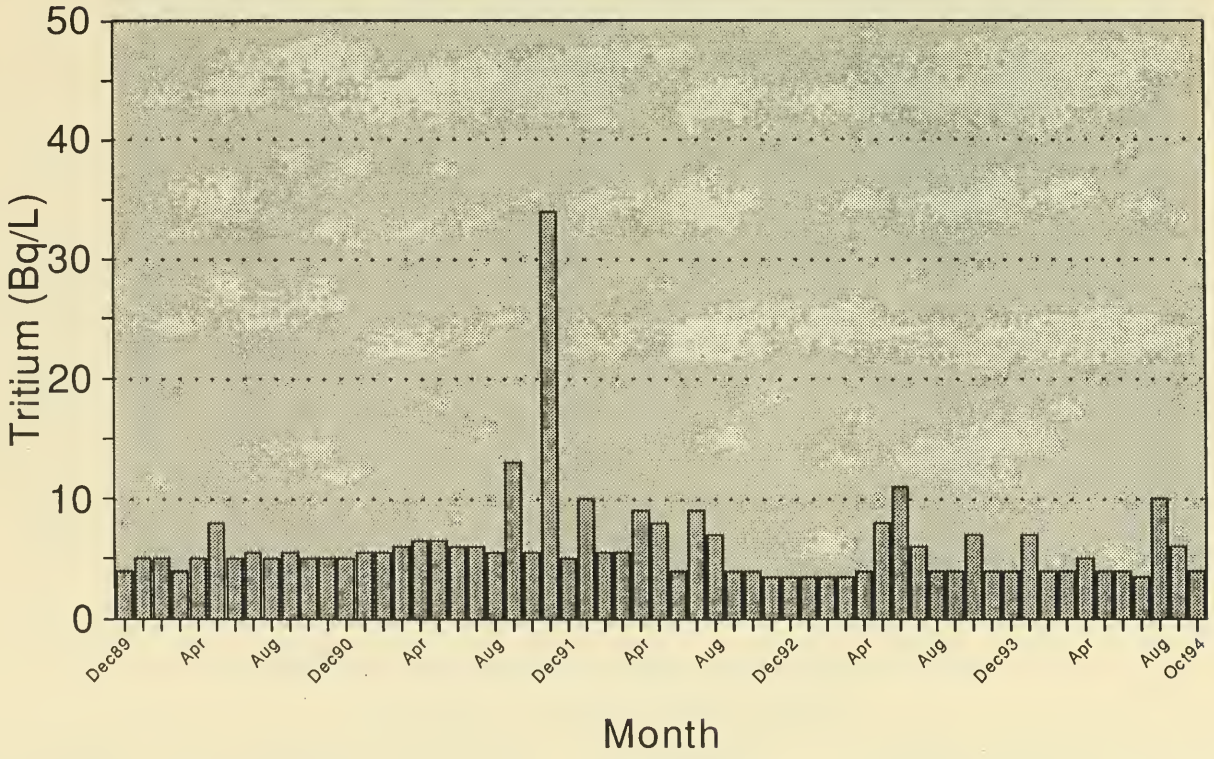
Weekly Tritium Averages
Period December 1988 - November 1994



Data Source: Ontario Ministry of Labour

Amherstburg Water Treatment Plant

Monthly Tritium Averages
Period: December 1989 - October 1994

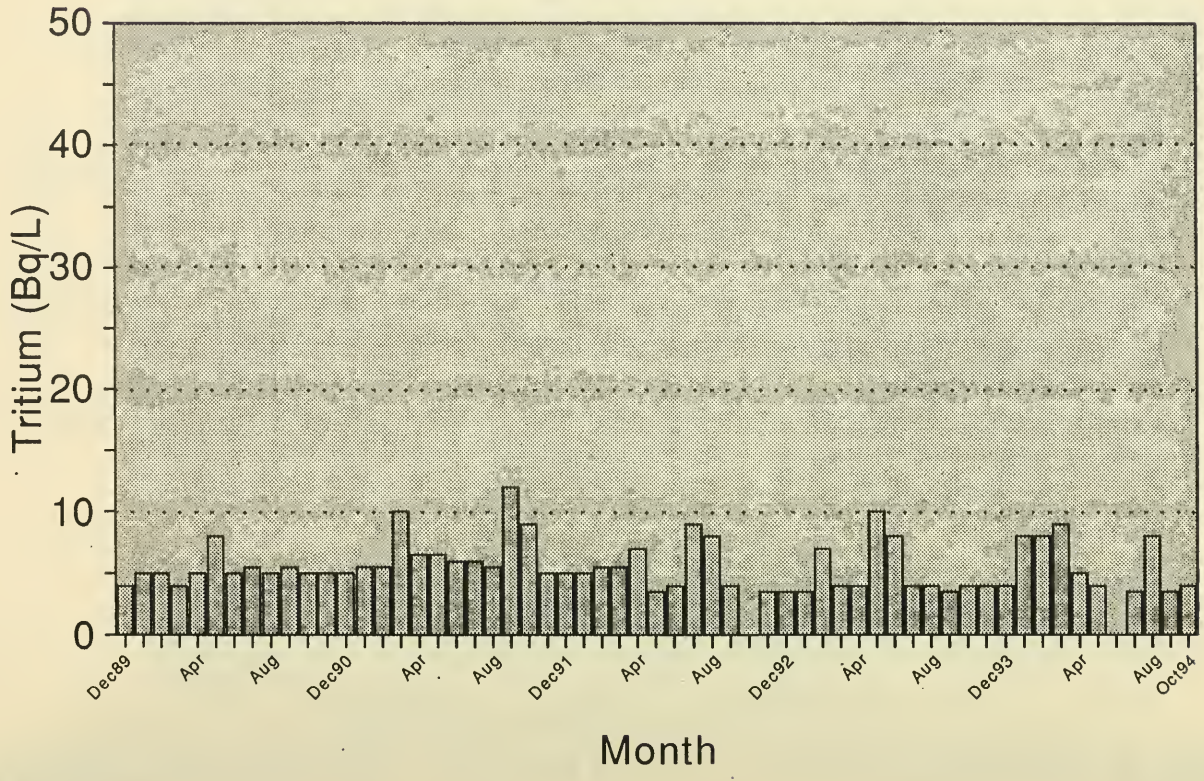


Source: Ontario Ministry of Labour

Harrow-Colechester Water Treatment Plant

Monthly Tritium Averages

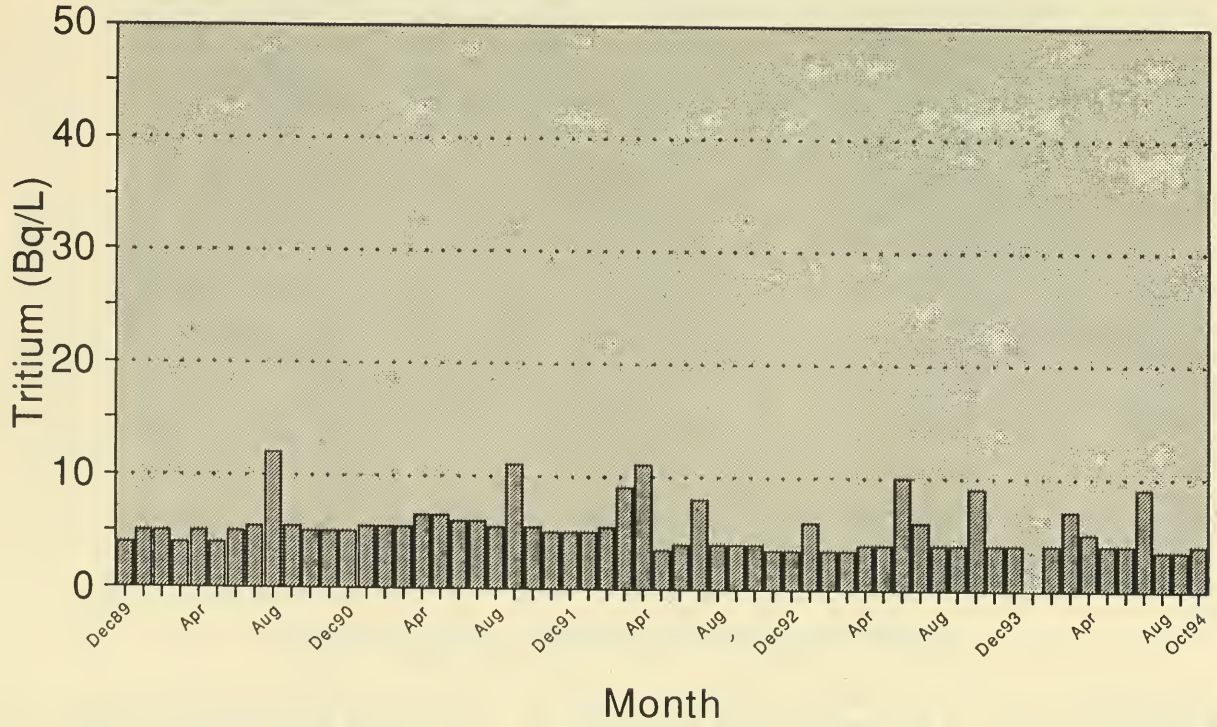
Period: December 1989 - October 1994



Source: Ontario Ministry of Labour

Wheatley Water Treatment Plant

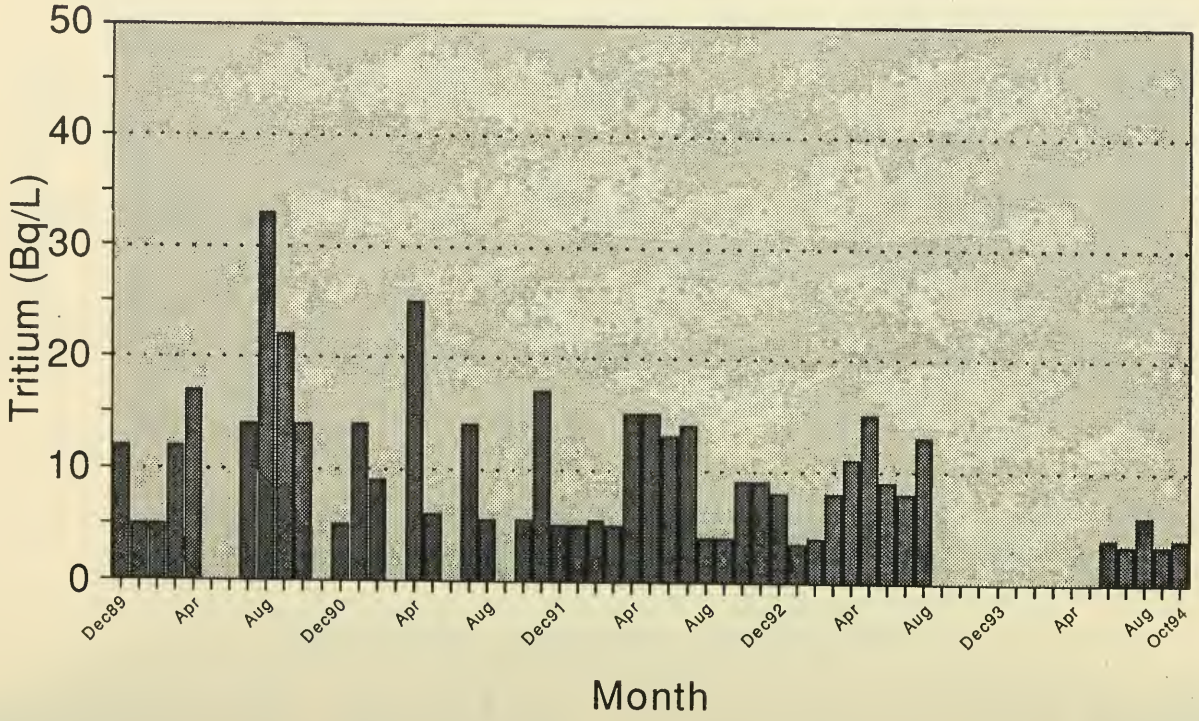
Monthly Tritium Averages
Period: December 1989 - October 1994



Source: Ontario Ministry of Labour

Petawawa Treatment Plant

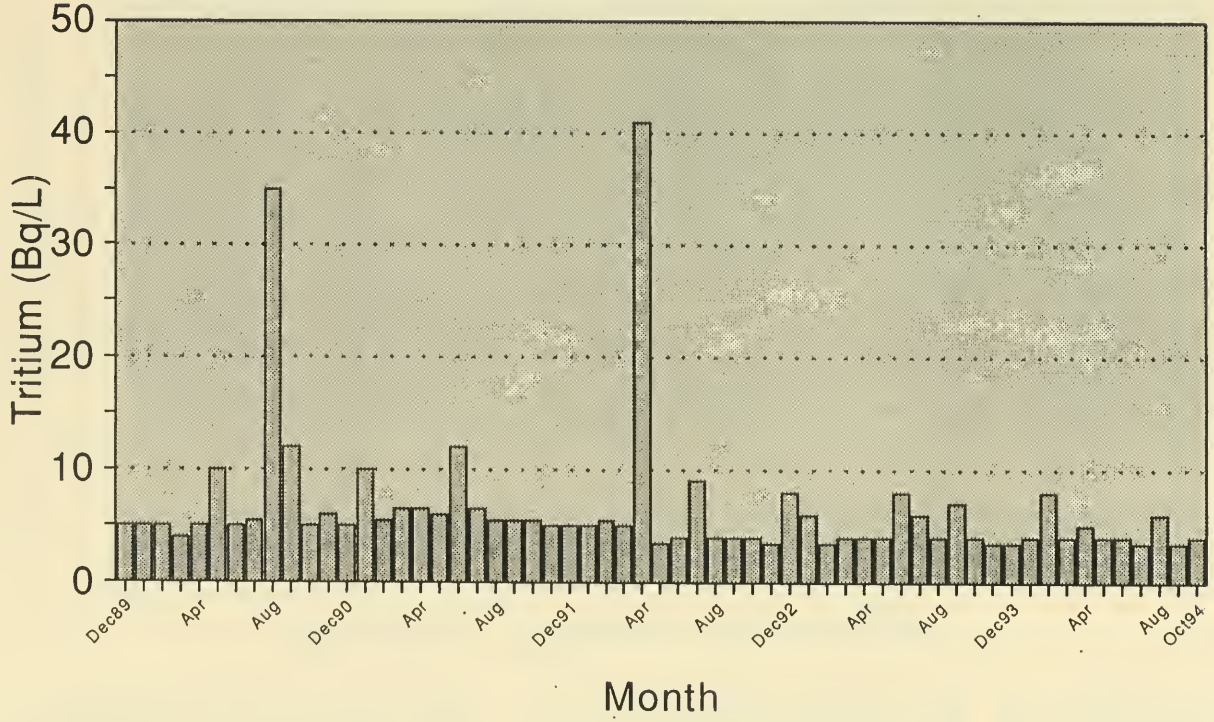
Monthly Tritium Averages
Period: December 1989 - October 1994



Source: Ontario Ministry of Labour

Deep River Treatment Plant

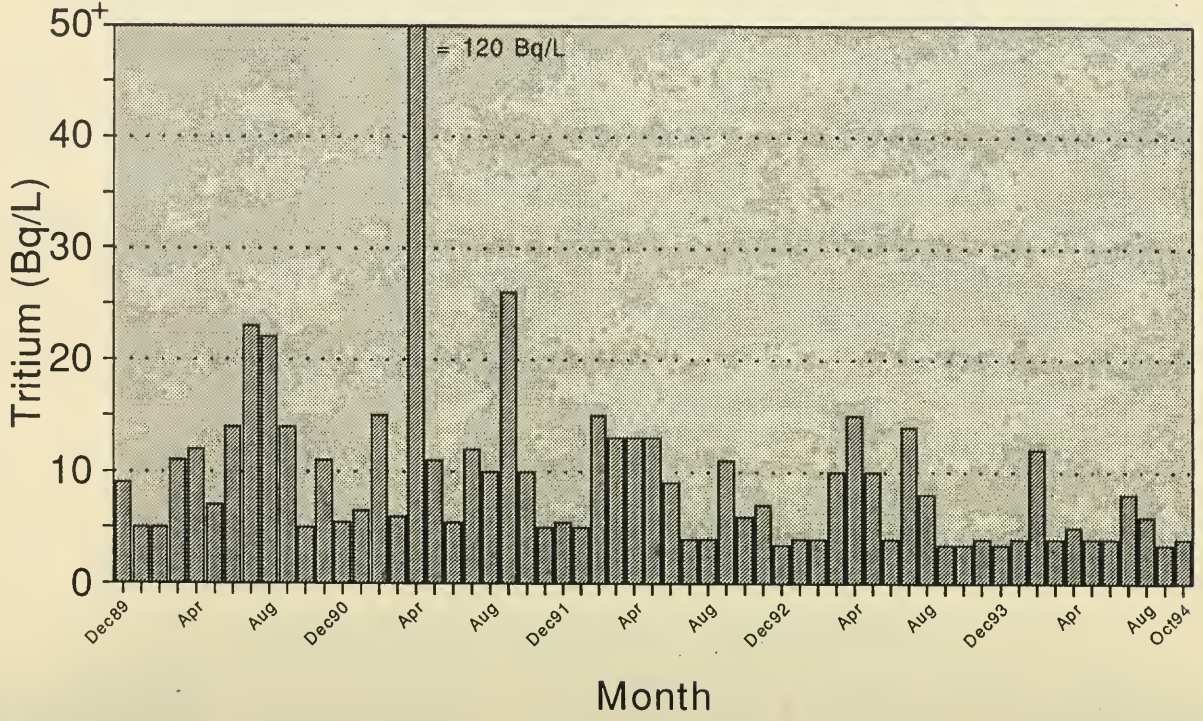
Monthly Tritium Averages
Period: December 1989 - October 1994



Source: Ontario Ministry of Labour

Pembroke Treatment Plant

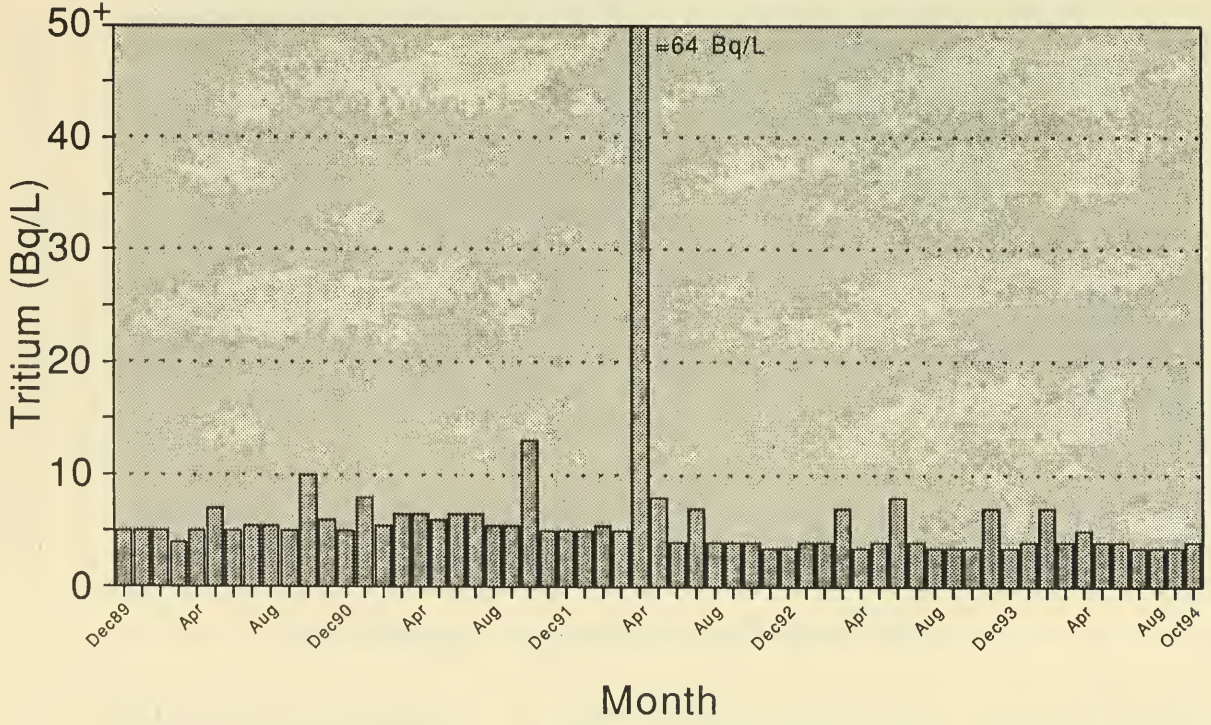
Monthly Tritium Averages
Period: December 1989 - October 1994



Source: Ontario Ministry of Labour

Rolphton Treatment Plant

Monthly Tritium Averages
Period: December 1989 - October 1994

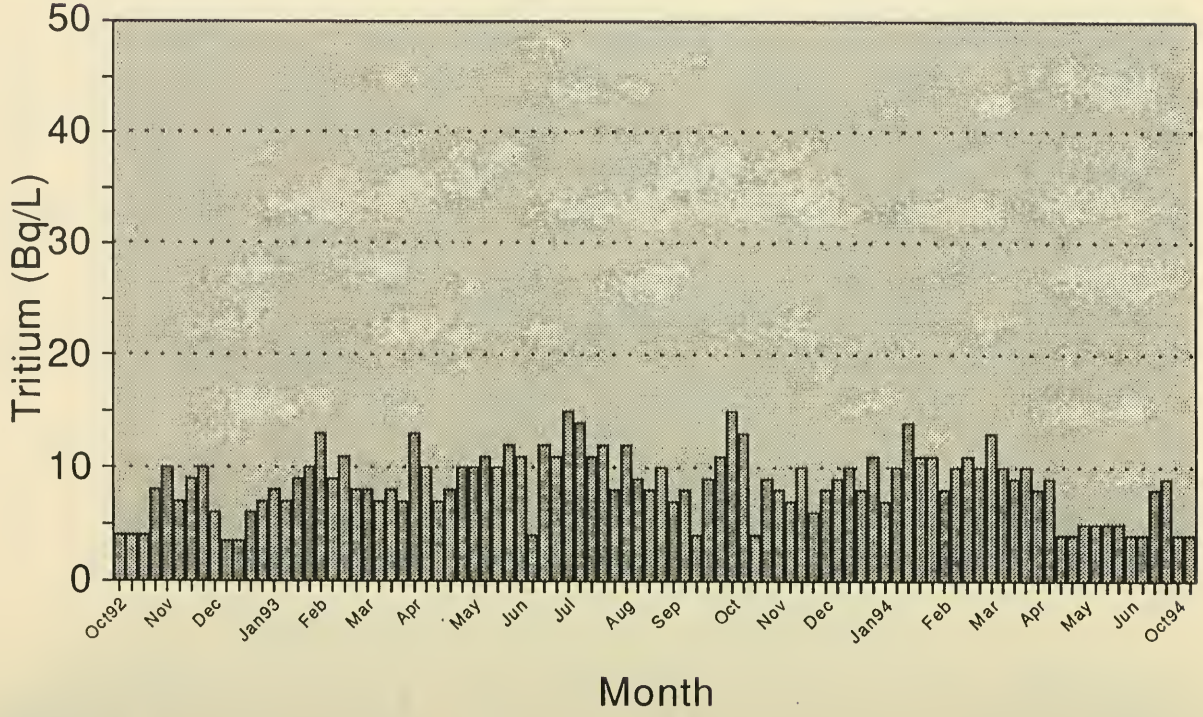


Source: Ontario Ministry of Labour

Lakeview Treatment Plant

Weekly Tritium Averages

Period: October 1992 - November 1994

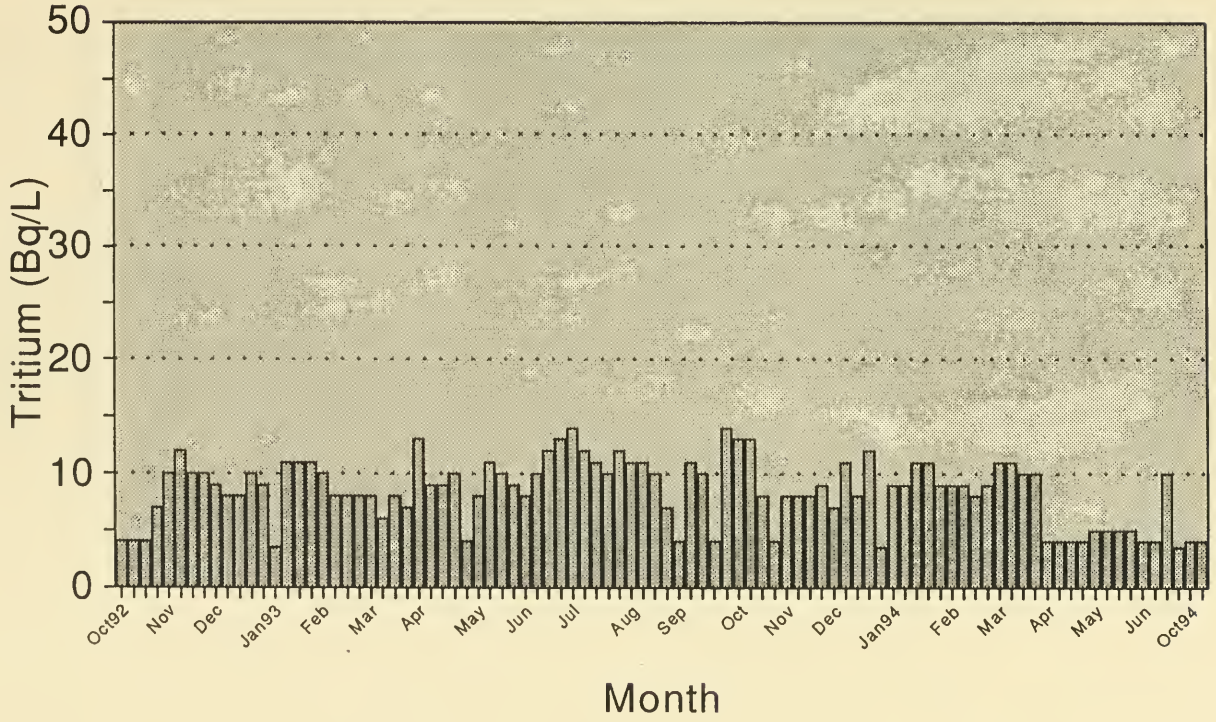


Data Source: Ontario Ministry of Labour

Lornepark Treatment Plant

Weekly Tritium Averages

Period: October 1992 - November 1994



Data Source: Ontario Ministry of Labour

APPENDIX F

LETTERS FROM
MINISTER C.J. (BUD) WILDMAN

TO

MINISTER OF HEALTH CANADA
AND
MINISTER OF NATURAL RESOURCES CANADA

Minister
Ministre

Ministry of Environment and Energy

Ministère de l'Environnement et de l'Énergie

135 St. Clair Avenue West
Suite 100
Toronto ON M4V 1P5

135, avenue St. Clair ouest
Bureau 100
Toronto ON M4V 1P5

47847

DEC 2 2 1994

Honourable Diane Marleau
Health Canada
Minister's Office
Brooke Claxton
0916A
Ottawa, Ontario
K1A 0K9

Dear Ms. Marleau:

I am writing to advise you of the new interim Ontario drinking water objective for tritium, of 7000 Becquerels per litre (Bq/L). I am also pleased to inform you that Ontario Hydro has made a corporate commitment to keep tritium levels in drinking water to an annual average of 100 Bq/L.

I would like to formally bring to your attention the attached report on a "Standard for Tritium" prepared by my Advisory Committee on Environmental Standards (ACES). I ask that your staff consider this report in their review of the Canadian Drinking Water Guidelines for radionuclides.

ACES has raised the complex issue of the differences in acceptable risk levels for radionuclides and those used in regulating industrial chemicals and pesticides. The issue of the disparity and inconsistency in acceptable risk approaches has also been a matter of concern in the United States. The US government's General Accounting Office has highlighted this consistency problem and recommended developing "...interagency consensus on preferred radiation dose and risk calculation methods and radiation protection strategies, as well as an overall consensus on how much radiation risk to the public is acceptable" in November 1994 (Report GAO/CED-94-190).

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The issue of acceptable risk is not only a matter for technical experts, but a matter of considerable public concern. Balancing risks and costs of control pose difficult challenges to us in government. The issues cannot be ignored but need to be discussed broadly. In this context, I have also written to Anne McLellan, Minister of Natural Resources, to request her commitment to expedite the reduction of the allowable radiation dose used by the Atomic Energy Control Board in regulating nuclear facilities in Canada.

I would like your concurrence that these matters will be addressed by your department in the federal/provincial discussions on drinking water guidelines for radionuclides currently on-going at the staff level. In the interest of harmonization, our interim objective will be reviewed when the Canadian Drinking Water Guidelines for radionuclides are completed. I look forward to your reply.

Sincerely,

Bud Wildman

C.J. (Bud) Wildman
Minister

Attachment "A Standard for Tritium: A recommendation to the Minister of Environment and Energy", May 1994 by the Advisory Committee on Environmental Standards

Minister
Ministre

Ministry of Environment and Energy
Ministère de l'Environnement et de l'Énergie

135 St. Clair Avenue West
Suite 100
Toronto ON M4V 1P5

135, avenue St. Clair ouest
Bureau 100
Toronto ON M4V 1P5

DEC 2 2 1994

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Honourable Anne McLellan
Natural Resources Canada
Minister's Office
580 Booth St.
21st floor
Ottawa, Ontario
K1A 0E4

Dear Ms. McLellan:

I am writing to you to ask for your commitment to accelerate the reduction of the allowable radiation dose used by the Atomic Energy Control Board (AECB) in regulating nuclear facilities in Canada.

In 1990, the International Council for Radiation Protection (ICRP) reduced the allowable radiation dose for the general public. The maximum allowable dose, excluding background radiation and medical/dental x-rays, is now 1 millisievert (Msv) per year reduced from 5 millisieverts (Msv) per year. The AECB continues to use 5 Msv per year as the maximum allowable dose, in licensing nuclear facilities.

I have just announced an interim tritium drinking water objective for Ontario of 7000 Bq/L based on the 1990 ICRP revisions and subsequent World Health Organization recommendations. As you know, the federal government, through the AECB, is responsible for monitoring and setting limits on emissions of radionuclides in Canada. Ontario Hydro has agreed to continue to keep tritium levels in drinking water to an annual average of 100 Bq/L. This commitment was in response to my Advisory Committee on Environmental Standards (ACES) who conducted a public consultation of the tritium drinking water objective and recommended much lower levels.

I have also written to Diane Marleau, Minister of Health Canada, to advise her of my decision on the tritium objective and to request her consideration of the ACES recommendations as part of their ongoing review of the Canadian Drinking Water Guidelines for radionuclides.

. . . 2

I am sure you will agree that it is important to assure the public that both of us are carrying out health and environmental protection to the full extent of our mandates. I would appreciate your consideration of the ACES report and I look forward to hearing from you as to when you will complete the proposed revision of AECB's allowable radiation dose.

Sincerely,

Bud Wildman

C.J. (Bud) Wildman
Minister

Attachment "A Standard for Tritium: A recommendation to the Minister of Environment and Energy", May 1994 by the Advisory Committee on Environmental Standards